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Cover photograph: Arctic Tern at nest near Churchill, Manitoba, by Donald A. Smith. See note on possible spring migration route on page 51

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Ecological Distribution of the Meadow Vole, *Microtus pennsylvanicus terraenovae*, (Rodentia: Cricetidae), on the Main Island of Newfoundland

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Abstract. One hundred and ninety-five meadow voles, *Microtus pennsylvanicus terraenovae* (Rodentia: Cricetidae), were trapped on the main island of Newfoundland during 11,062 trap nights during a 7-year period, 1965-1971. Voles were scarce throughout most of the island. They were captured most frequently in grassy habitats, occasionally in barrens or bogs and only rarely in disturbed areas or coniferous forests.

Meadow voles exhibit a strong preference for grassland habitat on the main island of Newfoundland as they do on the mainland of North America.

The eastern meadow vole, *Microtus pennsylvanicus* (Ord), is distributed widely throughout much of North America. Over most of its range, this species is confined to moist meadow-like habitats (Blair, 1940; Findley, 1951; Getz, 1961; Hamilton, 1940). Occasionally, however, it penetrates woodlands, bogs and other non-meadow habitats. In Maryland, Stickel (1960) found that *M. pennsylvanicus* regularly occupied woodlot borders and occasionally even pine-dominated areas with little ground cover. Buckner (1957) noted that meadow voles were the dominant small mammals in open stands of *Larix* and *Picea* in Manitoba. Beer *et al.* (1954) reported that *M. pennsylvanicus* commonly inhabited forests in Minnesota along with *Clethrionomys gapperi*. Morris (1969) found that, during the winter, both these species of voles inhabited aspen stands in Saskatchewan.

On islands *Microtus* often inhabits woodlands and sometimes reaches even higher densities than in similar habitat on the mainland. Dice (1925), Beer *et al.* (1954), Webb (1965), Manville (1951) and Werner (1956) all have reported meadow voles occupying forested islands in freshwater lakes. In oceanic island situations, MacKay (1963) found *M. pennsylvanicus* on the Grand Manan Archipelago occupying both forest and grassland, while Cameron (1958, 1962, 1965) found meadow voles inhabiting forests on Magdalen Island, Bonaventure Island, Ile-aux-Coudres and the island of Newfoundland.

Most of Newfoundland is covered by extensive coniferous forests, barrens and bogs while grassy areas are uncommon. Cameron (1958) stated that . . . "the meadow mice of Newfoundland are of particular interest because they appear not to be restricted to the grasslands . . .". Twenty-seven of the 43 specimens he collected were taken in forested areas (Cameron, 1965). This suggested to him that *Microtus* on Newfoundland differed significantly in its habitat selection from *Microtus* on the mainland.

Microtus pennsylvanicus terraenovae (Bangs) is the only small cricetid rodent occupying the island of Newfoundland.

We obtained information on numbers and distribution independently between 1965 and 1971 during studies of the ecology of *Microtus* (J.D.F., R.R.R., W.O.P.) and while collecting specimens for use in other research (Grant, 1970). The work was supported in part by National Research Council of Canada grants to Pruitt (NRC-B3492) and Grant (NRC-A2920) and by Canadian Wildlife Service con-

tract to Pruitt, (CWS 6869-064). We are grateful to Lorna Payne, Harvey Payne and Roger Wilson for assistance in trapping.

Methods and Description of Habitats

We employed two basic methods in the collection of specimens. Pruitt, from 1965 to 1971, trapped standard 1-acre plots with 5,700 trap nights (TN) using Schuyler No. 3 and Museum Special snap traps, (Pruitt, 1966, 1968, 1972). Folinsbee and Riewe in 1967 (3,894 TN), Folinsbee in 1968 (1,201 TN) and Grant in 1968 (267 TN) using Sherman and Longworth live traps, Museum Special, Schuyler, and Victor 4-way snap traps selectively trapped various habitats in an attempt to collect as many animals as possible. Figure 1 shows the distribution of trapping sites. Traps were placed in runways, near observed vole sign or spaced in a grid.

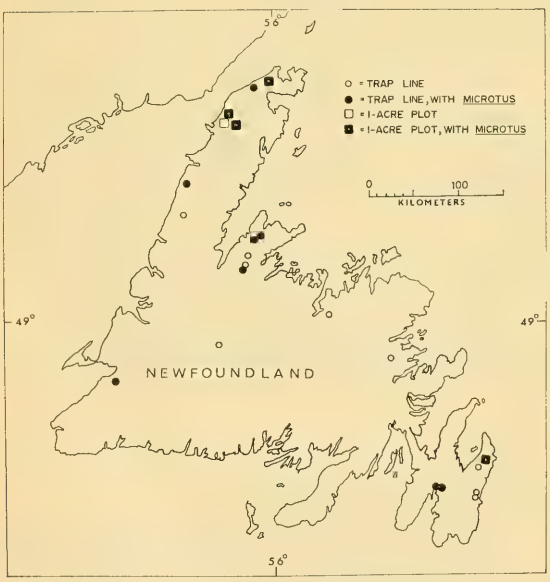

FIGURE 1. Trapping sites on the island of Newfoundland utilized between 1965 and 1971 for the capture of *Microtus pennsylvanicus terraenovae*.

We trapped five major habitat types:

1. Grassland: treeless habitat with a ground cover dominated by grasses or sedges. We include pastures, hay meadows, fens and sites of abandoned lumber camps in this type. Areas ranged from dry to wet but *Sphagnum* was never present in significant amounts.

2. Barrens: variable habitat, including alpine heath and low-growing spruce-fir (*Picea mariana* and *Abies balsamea*) "tuckamoor" or krumholz characterized by ericaceous shrubs, mosses and lichens. This habitat type is commonly found along the exposed coastal regions and ridge tops.

3. Bogs: habitat with substratum of *Sphagnum,* occasionally a few trees or shrubs such as *Picea mariana, Latrix laricina, Ledum groenlandicum* and *Kalmia angustifolia.* We include *Carex* and *Scirpus* bogs in this category.

4. Disturbed areas and deciduous woods: including roadsides, trails, survey lines, cutovers and recent burns. These areas generally lack tree cover. Grass-like vegetation is scarce but herbs and shrubs such as *Epilobium, Rubus, Cornus,* young *Populus* and *Alnus* are common. Mature deciduous forests are included here because most deciduous forests in Newfoundland are the result of disturbance by man or fire.

5. Coniferous forests: areas of good-sized conifer trees, mainly spruce and fir, ranging from wet boggy forests to dry upland forests.

Results and Discussion

Our trapping results are presented by habitat category in Table 1. Two salient facts emerge from these data: (1) Meadow voles were generally scarce throughout Newfoundland, and (2) we captured them frequently in grasslands but only occasionally in barrens and bogs and rarely in disturbed areas and coniferous forests.

The second finding appears to be in conflict with the trapping success of Cameron (1965). He reports trapping 27 of 43 *Microtus* in wooded habitats. However, his earlier paper (Cameron, 1958) makes it clear that almost all animals were trapped in overgrown glades in woodlands, paralleling some of our results and those of others in some mainland situations (e.g. Buckner, 1957; Clough 1964; Connor

TABLE 1. — Trapping results of *Microtus pennsylvanicus* in five habitats on the main island of Newfoundland

Habitat	1965		1966		1967		1968		1969		1970		1971		Total		
	TN	Voles	TN	Voles	TN	Voles	TN	Voles	TN	Voles	TN	Voles	TN	Voles	TN	Voles	Voles / 100 TN
Grassy areas	–	–	–	–	1,839	142	97	8	–	–	–	–	–	–	1,936	150	7.75
Barrens	–	–	300	0	615	0	300	2	300	3	600	8	600	15	2,715	28	0.76
Bogs	300	0	600	2	988	7	435	5	–	–	300	0	300	0	2,923	14	0.41
Disturbed areas	–	–	–	–	688	1	361	0	–	–	–	–	–	–	1,049	1	0.10
Coniferous forests	–	–	300	0	964	0	875	0	–	–	300	2	–	–	2,439	2	0.08
														Totals	11,062	195	$\bar{X}$ = 1.76

1960; Garbutt 1961; Smith and Foster 1957). Cameron's results and ours are therefore not incompatible.

We conclude that *Microtus pennsylvanicus* exhibits a strong preference for grassland habitats on the main island of Newfoundland. It is generally rare on Newfoundland because of the scarcity of this habitat. Cameron appears to have overestimated the use of woodland by *Microtus* on Newfoundland, and it is not obvious that the use of woodland is greater on Newfoundland than in certain, mainly northern, localities on the mainland.

Literature Cited

Beer, J. R., P. Lukens and D. Olson. 1954. Small mammal populations on the islands of Basswood Lake, Minnesota. Ecology 35: 437-445.

Blair, W. F. 1940. Home ranges and populations of the meadow vole in southern Michigan. Journal of Wildlife Management 4: 149-161.

Buckner, C. H. 1957. Population studies of small mammals of southeastern Manitoba. Journal of Mammalogy 38: 87-97.

Cameron, A. W. 1958. Mammals of the islands in the Gulf of St. Lawrence. National Museum of Canada, Bulletin No. 154, 165 p.

Cameron, A. W. 1962. Mammalian zoogeography of the Magdalen Islands Archipelago, Quebec. Journal of Mammalogy 43: 505-514.

Cameron, A. W. 1965. Competitive exclusion between the rodent genera *Microtus* and *Clethrionomys*. Evolution, 18: 630-634.

Clough, G. C. 1964. Local distribution of two voles: evidence for interspecific interaction. Canadian Field-Naturalist 78: 80-89.

Connor, P. F. 1960. The small mammals of Otsego and Schoharie counties, New York. New York State Museum Science Service, Bulletin 382, 84 p.

Dice, L. R. 1925. The mammals of Marion Island Grand Traverse County, Michigan. University of Michigan Museum of Zoology, Occasional Papers No. 160, 10 p.

Findley, J. S. 1951. Habitat preferences of four species of *Microtus* in Jackson Hole, Wyoming. Journal of Mammalogy 32: 118-120.

Garbutt, P. D. 1961. The distribution of some small mammals and their associated fleas from central Labrador. Ecology, 42: 518-525.

Getz, L. L. 1961. Home ranges, territoriality, and movement of the meadow vole. Journal of Mammalogy 42: 24-36.

Grant, P. R. 1970. Experimental studies of competitive interaction in a two-species system. II. The behaviour of *Microtus, Peromyscus* and *Clethrionomys* species. Animal Behaviour 18: 411-426.

Hamilton, W. J., Jr. 1940. Life and habits of field mice. Science Monthly, 50: 425-434.

MacKay, A. A. 1963. A comparative zoogeographical study of the mammals occurring on the islands of the Grand Manan Archipelago, New Brunswick. Unpublished report, McGill University Zoology Department (not seen, cited from Cameron, 1965).

Manville, R. H. 1951. A small island community in midsummer. Ecology, 32: 608-617.

Morris, R. D. 1969. Competitive exclusion between *Microtus* and *Clethrionomys* in the aspen parkland of Saskatchewan. Journal of Mammalogy 50: 291-301.

Pruitt, W. O., Jr. 1966. Ecology of terrestrial mammals, p. 519-564. *In* N. J. Wilimovsky and J. N. Wolfe (eds.) Environment of the Cape Thompson region, Alaska. U.S. Atomic Energy Commission, Division of Technical Information, PNE-481.

Pruitt, W. O., Jr. 1968. Synchronous biomass fluctuations of some northern mammals. Mammalia 32: 172-191.

Pruitt, W. O., Jr. 1972. Synchronous fluctuations in small mammal biomass on both sides of a major zoogeographic barrier. Aquilo, Ser. Zoologica 13: 40-44.

Smith, D. A., and **J. B. Foster.** 1957. Notes on the small mammals of Churchill, Manitoba. Journal of Mammalogy 38: 98-115.

Stickel, L. F. 1960. *Peromyscus* ranges at high and low population densities. Journal of Mammalogy 41: 433-441.

Webb, W. L. 1965. Small mammal populations on islands. Ecology, 46: 479-488.

Werner, W. E., Jr. 1956. Mammals of the Thousand Islands region, New York. Journal of Mammalogy 37: 395-406.

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Food Habits of Insular Meadow Voles, *Microtus pennsylvanicus terraenovae*, (Rodentia: Cricetidae) in Notre Dame Bay, Newfoundland

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Abstract. The food habits of *Microtus pennsylvanicus terraenovae* on the islands in Notre Dame Bay, Newfoundland were studied between May 1967 and August 1969 by means of selective food preference tests and field observations. A total of 64 vascular and 9 non-vascular plant species was recorded in the voles' diets. *Microtus* take advantage of herbaceous vegetation in summer and autumn, but it is available only in small isolated areas. A considerable number of plants characteristic of forest habitats are present in the meadow voles' diets the year round, indicating that the voles' appetites are well adjusted to their existence in these habitats. Evidence also suggests that insular meadow voles occasionally scavenge on animal remains.

Introduction

Throughout their range *Microtus* spp. are primarily grazers, feeding on the vegetative parts of grasses and forbs, although, during the winter, the bark of trees and shrubs is often included in their diets (Bailey, 1924; Godfrey, 1953; Linduska, 1950; Siegler, 1937; Thompson, 1965, and others). Occasionally seeds, nuts and berries are also consumed (Martin, 1956; Williams, 1955). A few investigators have even reported that *Microtus* have a propensity for meat (Martin, 1956; Wellwood, 1956; Zimmerman, 1965).

As part of an ecological study conducted from May 1966 to August 1969, I gathered information on the voles' food habits on the islands in Notre Dame Bay.

Study Area

The study area is located in Notre Dame Bay, on the east coast of Newfoundland. The geology, physiography, climate, human occupation and habitats of the study area are being described elsewhere (Riewe and Pruitt, MS in preparation[1]).

Basically, there are eight major habitat types in the study area: spruce-fir forest, tuckamoor (krumholz-like forest), alder patch, dwarf shrub barren, grassy area, bog, salt marsh and shoreline. The islands are primarily forested with spruce-fir forests. Lesser areas are covered by tuckamoor, bog, dwarf shrub barren and alder patch. Grassy areas are restricted to very small islands and man-made clearings on larger islands. Shoreline habitat is common to every island, but usually forms only a small percent of the cover. Salt marsh is the most restricted of all habitat types.

The biological environment occupied by *Microtus pennsylvanicus* in Notre Dame Bay is quite unusual for this species. In this area meadow voles are relatively free from potential competitors. I investigated a total of 89 islands. Meadow vole sign was present on 59 islands ranging in size from less than 0.08 ha to 18,000 ha; meadow voles were the only rodents found on 53 islands.

Varying hares (*Lepus americanus*) were found in small numbers on many of the islands larger than 25 ha. Red squirrels (*Tamiasciurus hudsonicus*) and red-backed voles (*Clethrionomys gapperi*) have been introduced to a 61-ha island, while European bank voles (*C. glareolus*) have been introduced to a 57-ha island. Scattered populations of house mice (*Mus musculus*) and Norway rats (*Rattus norvegicus*) were only rarely encountered on the islands.

[1]Observations on the vegetation of the islands in Notre Dame Bay, Newfoundland.

Materials and Methods

In order to ascertain which components of the local flora are important items in the voles' diets, I conducted selective food preference tests similar to those employed by Thompson (1965). These tests were conducted during winter (18 March to 4 April, 1969) and summer (16 to 22 August, 1969) on South Trump Island. This 172-ha island is covered with approximately 150 ha of spruce-fir and tuckamoor forests, 10 ha of dwarf shrub barren, 8 ha of bog, 2 ha of grassy area and 1 ha of salt marsh.

To 13 voles captured on the island I offered 45 species of vascular and seven species of non-vascular plants; nineteen of these plant species were tested in both seasons.

The voles were caged individually in Fiberglas flower boxes (60 × 20 × 15 cm) with screen tops. Wood shavings for litter and terylene fiber for nest material were provided. Water in dishes (summer) or snow balls (winter) were supplied *ad libitum*. I kept the caged animals in an unheated shed where the ambient temperature was close to that of the macro-environment. At the beginning of each test I placed five to seven species of plants in each cage along with an excess of Purina laboratory mouse chow, thereby allowing the subjects to refuse all plant species offered and to subsist on the lab chow. I recorded the amounts and the parts (such as berries, roots, stems, etc.) of the plants given to each vole. After three days, I removed the voles and examined the food remains. Each plant species was given a rating A through D, depending upon the percent consumed (A = 0%, B = 1-30%, C = 31-60%, D = 61-100%). In addition to these selective preference feeding tests, I made numerous observations of *Microtus* feeding sign in the field.

Results and Discussion

The results of the selective food preference tests conducted in the summer and winter seasons are presented in Tables 1 and 2, respectively. For each season I divided the plants into five categories based on the voles' acceptance of the species. Class I include those species readily eaten by all voles; class IV included those plants rejected by all test animals. The voles displayed intermediate levels of acceptance to the plants in classes II and III. Class V is composed of those plant species which met with varying degrees of acceptance; some of the test animals rejected the species, others consumed small to moderate portions, while still others readily devoured them. The presence of class V points out that the voles possessed highly individualistic appetites.

Elsewhere I have shown that meadow voles on the larger islands in Notre Dame Bay generally inhabit forest and shrub barren habitats on a year-round basis, but occupy grassy areas and bogs only during the summer and autumn (Riewe, 1972). A large number of plants characteristic of spruce-fir forest, tuckamoor and dwarf shrub barren habitats, particularly ericaceous species, are present in class I and V, Table 1 and 2. The voles' acceptance of these species indicates that their appetites are adjusted to their existence in these habitats. The predominance of typical meadow grasses and forbs in class I, Table 2, demonstrate that the *Microtus* have a definite preference for herbaceous vegetation and take advantage of it when it is available.

Data from field observations, as well as from the food preference tests, are listed by growth forms in Table 3. The table should not be considered exhaustive since the grasses, sedges and rushes and probably the lichens and mosses as well, are under-represented owing to the difficulty of identifying these groups in the field, particularly in the winter.

Although the voles rejected *Cladonia rangiferina* in the feeding tests, I observed sign which suggested that one lichen might be utilized by voles in the study area. I discovered exposed subnivean runways filled with the foliose lichen, *Peltigera* sp. Although the thalli had vole tooth marks on them, there is the possibility that the lichen had only been cleared from the runways. To my knowledge, there are no reports of *Microtus* feeding on lichens, but Llano (1956) mentioned that lemmings consumed tundra lichens.

TABLE 1. — Results of winter food preference tests on *Microtus pennsylvanicus terraenovae*.

Species	Number of voles tested	Portion consumed by each vole[1]	Plant parts consumed[2]	Habitat[3]							
				1	2	3	4	5	6	7	8
I. Complete acceptance											
Pyrus floribunda	3	3D	bk, f		x			x	x		
Rosa nitida	7	7D	f					x	x		
Ledum groenlandicum	2	2D	l, f, st		x		x		x		
Kalmia angustifolia	2	2D	l, f, st	x	x		x		x		
Vaccinium angustifolium	6	1C, 5D	st, bk, bd		x		x		x		
V. Vitis-Idaea	3	3D	st, l	x	x	x	x		x		
Lonicera villosa	7	2C, 5D	bk, bd		x	x		x	x		
Hieracium floribundum	7	7D	l					x			
II. Moderate acceptance											
Betula Michauxii or *B. pumila*	7	5B, 2C	r, bk, st						x		
III. Poor acceptance											
Abies balsamea	7	6A, 1B	l	x	x	x					
Sanguisorba canadensis	7	6A, 1B	r		x	x		x	x		
Sarracenia purpurea	2	2B	l						x		
Gaultheria hispidula	7	1A, 6B	l	x	x		x				
Viburnum cassinoides	7	7B	bk		x	x		x			
Achillea Millefolium	3	1A, 2B	st, l, f					x			
IV. Rejection											
Fucus sp.	7	7A	none							x	x
Cladonia rangiferina	3	3A	none	x	x				x		
Rhacomitrium lanuginosum	7	7A	none					x			
Juncus sp.	7	7A	none	x					x	x	
V. Varying acceptance											
Sphagnum recurvum	7	5A, 2D	th	x					x		
Dicranum sp.	7	4A, 1B, 2D	th	x	x	x		x	x		
Pleurozium schreberi	7	6A, 1D	th	x	x			x			
Polytrichum sp.	6	1A, 5D	th					x	x		
Picea mariana	7	1A, 3B, 1C, 2D	l, bk	x	x	x			x		
Larix laricina	6	2A, 3B, 1D	bk		x				x		
Juniperus communis	3	1B, 2D	bk, st		x	x	x	x			
Myrica Gale	7	2B, 2C, 3D	bk, bd, f						x		
Alnus crispa	2	1A, 1C	st, bk		x	x	x	x			
Pyrus decora	7	1B, 3C, 3D	bk, bd		x	x		x			
Empetrum nigrum	7	1A, 6D	bk		x	x	x	x			
Rhododendron canadense	5	2B, 1C, 2D	bk, f		x		x		x		
Andromeda glaucophylla	7	1B, 1C, 5D	l, st						x		
Chamaedaphne calyculata	6	3B, 1C, 2D	l, st						x		

[1]Portion consumed: A = 0%; B = 1–30%; C = 31–60%; D = 61–100%.
[2]Plant parts: r = roots; st = stems; bd = buds; l = leaves; th = thalli; bk = bark; f = fruits, berries and seeds. Listed in descending order of utilization.
[3]Habitat code: 1 = spruce-fir forest; 2 = tuckamoor; 3 = alder patch; 4 = dwarf shrub barren; 5 = grassy area; 6 = bog; 7 = salt marsh; 8 = shoreline. The presence or absence of plant species in the 8 habitat types was determined by qualitative floral examinations of the islands in the study area.

I also found piles of *Sphagnum* spp., *Brachythecium* sp., *Dicranum polysetum* and *Ceratodon purpureus* clipped into small pieces by the voles. As with the lichens, I am not positive that these piles actually represented feeding sign. The selective food preference tests, however, demonstrated that the voles definitely fed on mosses. Although researchers in North America and Britain report that bryophytes are insignificant in the diets of voles and lemmings (Grout, 1903; Summerhayes, 1941; Thieret, 1956; Thompson, 1965), Russian

TABLE 2. — Results of summer food preference tests on *Microtus pennsylvanicus terraenovae*.[1]

Species	Number of voles tested	Portion consumed by each vole	Plant parts consumed	Habitat							
				1	2	3	4	5	6	7	8
I. Complete acceptance											
Polytrichum sp.	3	3D	th					x	x		
Alopecurus pratensis	6	6D	l, st, f					x			
Agropyron repens	3	3D	l, st, f					x			
Carex nigra	3	3D	l, st, f					x	x		x
Luzula campestris	3	3D	l, st, f					x	x		
Atriplex patula	3	3D	l, st, f					x			
Ranunculus repens	3	3D	l, f, st					x			
Sanguisorba canadensis	3	3D	l, f, fl, st		x	x		x	x		
Lathyrus japonicus	3	3D	l, st, f					x			x
Epilobium angustifolium	3	3D	f, l					x			
Vaccinium angustifolium	3	3D	l, f, st		x		x		x		
Lonicera villosa	3	3D	l		x	x		x	x		
Leontodon autumnalis	3	3D	l, st, f					x			
II. Moderate acceptance											
Pyrus decora	3	3C	l, st		x	x		x			
Veronica agrestis	3	2B, 1C	l					x			
Aster radula	3	2C, 1D	st, f					x	x		
Achillea Millefolium	3	1C, 2D	st, l, f					x			
III. Poor acceptance											
Myrica Gale	3	2A, 1B	l						x		
Rumex Acetosella	3	1A, 2B	f, l					x			
Thalictrum polygamum	3	2A, 1B	f			x		x	x		
Potentilla fruticosa	3	3B	l			x		x	x		
IV. Rejection											
Cladonia rangiferina	3	3A	none	x	x				x		
Abies balsamea	3	3A	none	x	x	x					
Picea mariana	3	3A	none	x	x	x			x		
Juniperus communis	3	3A	none		x	x	x	x			
Ribes sp.	3	3A	none	x				x			
Rubus idaeus	3	3A	none					x			
Solidago rugosa	3	3A	none			x		x			
V. Varying acceptance											
Larix laricina	3	1A, 1B, 1C	l		x				x		
Iris versicolor	3	1B, 2D	l, st					x			x
Pyrus floribunda	3	1A, 1B, 1D	l, f, bk		x			x	x		
Rosa nitida	3	1A, 2D	l, st, f					x	x		
Empetrum nigrum	3	2B, 1D	l		x	x	x	x			
Ledum groenlandicum	3	2A, 1D	l, bd, f		x		x		x		
Rhododendron canadense	3	1A, 2D	f, l		x		x		x		
Kalmia angustifolia	3	1A, 1B, 1D	f, l		x		x		x		
Vaccinium Vitis-Idaea	3	1A, 1B, 1D	l	x	x	x	x		x		
Plantago juncoides	3	1B, 1C, 1D	l								x

[1]Symbols same as in Table 1.

biologists stress the importance of mosses in microtine diets (Koshkina, 1961; Nasimovich *et al.*, 1948; Shtil'mark, 1965; Vorontsev, 1961).

In view of my observations I believe it is possible that the non-vascular plants played a significant role in the meadow voles' diets on the small, densely forested islands where this vegetation is dominant on the forest floor.

The grasses, sedges and rushes were available to the voles during the late spring, summer and fall; at these times they were heavily utilized. I

TABLE 3. — Foods of *Microtus* in Notre Dame Bay

Species	Part utilized[1]					Season of utilization[2]				Type of observation	
	r	st bd	l th	bk	f	Sp	Su	F	W	Field observation	Feeding test
Lichens and mosses											
Peltigera sp.			x						x	x	
Sphagnum recurvum			x						x		x
Sphagnum spp.			x						x	x	
Ceratodon purpureus			x						x	x	
Dicranum polysetum			x						x	x	
D. scoparium			x						x		x
Brachythecium sp.			x						x	x	
Pleurozium schreberi			x						x		x
Polytrichum sp.			x				x		x		x
Grasses, sedges and rushes											
Alopecurus pratensis		x	x		x		x	x			x
Agropyron repens		x	x		x		x	x			x
Scirpus cespitosus		x	x		x				x	x	
Carex nigra		x	x		x		x	x			x
Carex sp.		x	x		x		x	x		x	
Luzula campestris		x	x		x		x	x			x
Forbs											
Smilacina stellata		x	x				x			x	
Maianthemum canadense		x	x				x			x	
Iris setosa		x	x					x	x	x	
I. versicolor		x	x				x				x
Rumex acetosella			x		x		x				x
Atriplex patula		x	x		x		x			x	x
Ranunculus repens		x	x		x		x				x
Thalictrum polygamum					x						x
Sanguisorba canadensis	x	x	x		x		x	x		x	x
Cochlearia tridactylites		x	x					x		x	
Cakile edentula		x	x		x		x			x	
Sarracenia purpurea			x						x	x	x
Sedum Rosea		x	x				x			x	
Potentilla norvegica			x				x			x	
Trifolium spp.	x	x	x			x	x	x	x	x	
Lathyrus japonicus		x	x		x		x			x	x
Epilobium angustifolium			x		x		x				x
Cornus canadensis			x				x			x	
Ligusticum scothicum		x	x				x	x		x	
Conioselinum chinense		x	x				x			x	
Mertensia maritima		x	x				x			x	
Veronica agrestis			x				x				x
Plantago juncoides		x	x		x		x			x	x
Galium palustre or G. triflorum		x	x				x			x	
Solidago sempervirens			x				x			x	x
Aster radula		x	x		x		x				x
Aster spp.		x	x				x			x	
Achillea Millefolium		x	x		x		x				x
Leontodon autumnalis	x	x	x		x	x	x	x	x	x	x
Taraxacum officinale			x				x			x	
Hieracium floribundum			x						x		x

TABLE 3. *Continued*

Species	Part utilized[1]					Season of utilization[2]				Type of observation	
	r	st bd	l th	bk	f	Sp	Su	F	W	Field observation	Feeding test
Shrubs											
Taxus canadensis				x					x	x	
Juniperus communis		x	x	x	x			x	x	x	x
J. horizontalis			x	x		x	x	x	x	x	
Myrica Gale		x	x	x	x	x	x	x	x	x	x
Betula Michauxii or *B. pumila*	x	x		x					x		x
Alnus crispa				x	x			x	x	x	x
Pyrus decora			x	x	x	x	x	x	x	x	x
P. floribunda			x	x	x	x	x	x	x	x	x
Potentilla fruticosa			x				x				x
Rubus idaeus		x	x					x		x	x
Rosa nitida		x	x	x	x	x	x	x	x		x
Empetrum nigrum			x	x		x	x	x	x	x	x
Nemopanthus mucronata				x	x				x	x	
Ledum groenlandicum		x	x	x	x	x	x	x	x	x	x
Rhododendron canadense			x	x	x	x	x	x	x		x
Kalmia angustifolia		x	x	x	x	x	x	x	x	x	x
Andromeda glaucophylla		x	x	x					x	x	x
Chamaedaphne calyculata		x	x	x					x	x	x
Gaultheria hispidula			x						x		x
Vaccinium angustifolium		x	x	x	x	x	x	x	x	x	x
V. Oxycoccus		x	x		x			x		x	
V. uliginosum		x	x						x	x	
V. Vitis-Idaea		x	x			x	x	x	x	x	x
Lonicera villosa		x	x	x		x	x	x	x	x	x
Viburnum cassinoides				x	x				x	x	x
Trees											
Abies balsamea			x						x		x
Picea mariana		x	x	x					x	x	x
Larix laricina			x	x		x	x	x	x	x	x
Acer spicatum				x					x		x
Total: 73	4	42	68	22	31	15	46	28	41	51	48

[1]Part utilized: Symbols same as in Table 1.
[2]Season of utilization: Sp = spring; Su = summer; F = fall; W = winter.

also observed vole feeding sign on the apical shoots of *Scirpus cespitosus* in the winter.

Most of the forbs, like the grasses and their allies, were available primarily during the summer, but I found subnivean food caches stocked with the leaves and roots of *Leontodon autumnalis* and *Trifolium* spp. In February I discovered abundant sign of voles feeding upon the tough, bristly leaves of *Sarracenia purpurea;* one specimen had 25 of the 29 leaves eaten and half of these had been chewed to the roots.

On the small islands, the forbs along the shoreline, particularly *Plantago juncoides, Lathyrus japonicus, Ligusticum scothicum* and *Cochlearia tridactylites,* were heavily fed upon by *Microtus.* During hot, dry periods it is possible that the succulent shoreline species, *Plantago, Cochlearia,* as well as *Sedum, Mertensia* and *Cakile,* were sources of fresh water for the voles.

Surprisingly, the voles fed upon almost as many shrubs as forbs. The dominant species of

the dwarf shrub barrens were all utilized at one season or another. *Juniperus communis, Empetrum nigrum, Vaccinium angustifolium* and *V. Vitis-Idaea* were major overwintering foods. Voles often stripped the leaves and bark off these plants; such sign was clearly visible for one or two years. *Kalmia angustifolia* was an important item in the voles' diets throughout the year. Thompson (1965) tested the food preferences of *Microtus pennsylvanicus* on 30 species of plants; he found that native boreal and bog plants, including ericaceous species, occupied the eight lowest levels of preference.

None of the tree species appeared to be heavily utilized, but more feeding sign was noted on *Larix laricina* and *Picea mariana* than on *Abies balsamea* and *Acer spicatum.*

One of the most noteworthy features of Table 3 is the number and variety of plants. Undoubtedly I overlooked species of plants utilized by *Microtus.* Nonetheless, this list of 73 species includes 24.8% of all plants recorded from the study area.

Table 4 lists the eight major habitats in the Notre Dame Bay study area and includes the number of vascular plants recorded for each habitat and the number of species fed upon in each by *Microtus.* The non-vascular plants were omitted because there is no comprehensive list available. Table 4 does not take into account the abundance nor the degree of cover of the species in each habitat, nor the voles' food preferences, but it does give an indication of the number of species which could be utilized by *Microtus* in each of the habitats. The numbers suggest that the voles of Notre Dame Bay could subsist on the available plant species in most of the major habitats. The only possible exception is the salt marsh, but, owing to the scarcity of this habitat in the study area, my data are very limited.

TABLE 4. — Number of vascular plant species utilized by *Microtus* in the major habitats of the islands of Notre Dame Bay.

Habitat	Number of vascular plant species	
	Eaten by *Microtus*	Recorded
Spruce-fir forest	11	41
Tuckamoor	20	33
Alder patch	12	18
Dwarf shrub barren	15	21
Grassy area	36	98
Bog	25	69
Salt marsh	1	23
Shoreline	11	30

In addition to the plants, some of the meadow voles may have included animal tissue in their diets. I base this statement on the following evidence:

1. Lobster traps which are stored on the islands were often destroyed by meadow voles (Figure 1). The local fishermen were of the opinion that the voles chewed through the netting of their traps to get at the lobster bait: cod heads (*Gadus*), tom cods (*Microgadus*), flounders (Bothidae) and cunners (*Tautogolabrus*), and attached marine invertebrates: purple starfish (*Asterias vulgaris*) green sea urchins (*Strongylocentrotus drobachiensis*) and periwinkles (*Littorina*).

2. I found the remains of crabs (*Cancer*), sea urchins, soft-shelled clams (*Myra arenaria*) and even small flounders deep in *Microtus* runways on many of the small islands. It is possible that these remains had been dropped or placed in the runways by foxes, ravens or gulls, but since no signs of these animals were present in the immediate vicinity, it seems more likely that the voles had dragged the remains into their runways.

3. On some islands the voles spent considerable time along the shorelines and even ventured into the intertidal zone (Riewe, 1971; Riewe, 1972). It is quite possible that the meadow voles which frequented the shorelines obtained a proportion of their enery requirements from the sea. Hatt *et al.,* (1948) noted that *Peromycus maniculatus gracilis* inhabiting the islands in Lake Michigan fed on a varied diet of beach drift including the remains of birds, fish, crayfish and snails.

In conclusion, meadow voles inhabiting the islands in Notre Dame Bay possess highly adaptable appetites. They show a preference for

Figure 1. Lobster traps stored on a small forested island in Notre Dame Bay. The bait in these traps very likely supplied the meadow voles which occupied this island with a source of protein.

herbaceous vegetation typical of grassy situations, but this fare is available only in small isolated areas in summer and autumn. The voles have adapted to the forest and dwarf shrub barren habitats by including a large variety of forest plants in their year-round diets. Evidence indicates that at least some voles take advantage of the sea's resources by scavenging along the shoreline.

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Literature Cited

Bailey, V. 1924. Breeding, feeding, and other life habits of meadow mice (*Microtus*). Journal of Agricultural Research, 27: 523-535.

Godfrey, G. K. 1953. The food of *Microtus agrestis* L. in Wytham, Berkshire. Saugetierkundliche Mitteilungen, 1: 148-151.

Grout, A. J. 1903. Mosses with hand-lens and microscope: a non-technical hand-book of the more common mosses of the northeastern United States. Published by the author, New York, 416 p.

Hatt, R. T., J. VanTyne, L. C. Stuart, C. H. Pope and **A. B. Grobman.** 1948. Island life: a study of the land vertebrates of the islands of eastern Lake Michigan. Cranbrook Institute of Science. Bulletin No. 27, 179 p.

Koshkina, T. V. 1961. New data on the nutrition habits of the Norwegian lemming (in Russian, English summary). Bulletin of the Moscow Society of Naturalists Biological Section, LXVI: 15-32.

Linduska, J. P. 1950. Ecology and land-use relationships of small mammals on a Michigan farm. Michigan Department of Conservation, Game Division, 144 p.

Martin, E. P. 1956. A population study of the prairie vole (*Microtus ochrogaster*) in northeastern Kansas. University of Kansas Publication Museum of Natural History, 8: 361-416.

Nasimovich, A., C. Novikov and **O. Semenov-Tyan-Shanskii.** 1948. The Norwegian lemming (its ecology and role in the nature complex of the Lapland Reserve). Materially po gryzunam, 3: 203-262. Translated in the Russian Translating Programme, National Lending Library for Science and Technology, Department of Scientific and Industrial Research, December 1961. RTS 1811. Boston Spa, Yorkshire.

Riewe, R. R. 1971. Ecology of the meadow vole, *Microtus pennsylvanicus terraenovae*, on the islands of Notre Dame Bay, Newfoundland, Canada. Unpublished Ph.D. Thesis, University of Manitoba, 231 p.

Riewe, R. R. 1972. Habitat utilization by meadow voles, *Microtus pennsylvanicus terraenovae*, (Mammalia: Rodentia: Cricetidae) on the islands in Notre Dame Bay, Newfoundland. Saugetierkundliche Mitteilungen. In Press.

Shtil'mark, F. R. 1965. Basic features of the ecology of mouse-like rodents in the stone-pine forests of western Sayan, p. 5 to 52. *In* Fauna of Stone-Pine Forests of Siberia and its Utilization. Academy of Science USSR, Moscow. Translated from Russian by E. Issakoff, edited by W. A. Fuller, typed copy from Library Boreal Institute, University of Alberta.

Siegler, H. R. 1937. Winter rodent damage to game cover. Journal of Mammalogy, 18: 57-61.

Summerhayes, V. S. 1941. The effect of voles (*Microtus agrestis*) on vegetation. Journal of Ecology, 29: 14-48.

Thieret, J. W. 1936. Bryophytes as economic plants. Economic Botany, 10: 75-91.

Thompson, D. Q. 1965. Food preferences of the meadow vole (*Microtus pennsylvanicus*) in relation to habitat affinities. American Midland Naturalist, 74: 76-86.

Vorontsev, N. N. 1961. Ecological and some morphological peculiarities of bank voles in the European north-east. Trudy ZIN Academy of Science USSR, XXIX. (Not seen, cited from Shtil'mark, 1965).

Wellwood, A. A. 1956. Some food preferences in field mice. Journal of Mammalogy, 37: 297-298.

Williams, O. 1955. The food of mice and shrews in a Colorado montane forest. University of Colorado Studies, Series in Biology, No. 3: 109-114.

Zimmerman, E. G. 1965. A comparison of habitat and food of two species of *Microtus*. Journal of Mammalogy, 46: 605-612.

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Ecological Notes on Manitoba *Napaeozapus insignis*

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Abstract. Twenty-six woodland jumping mice (*Napaeozapus insignis frutectanus*) were captured (1967-71) in deciduous forest bordering the Winnipeg River and its tributary creeks. Only two specimens of this mammal have been previously reported from Manitoba, and both were from coniferous forest. Our specimens were captured where the dominant vegetation included hazelnut (*Corylus cornuta*), trembling aspen (*Populus tremuloides*), ash (*Fraxinus nigra* and *F. pennsylvanica*), oak (*Quercus macrocarpa*) and strawberry (*Fragaria virginiana*). All were captured on or near slopes and within 100 m of permanent flowing water. Males apparently emerge from hibernation in late May and are in reproductive condition, whereas females do not emerge until early June. There was no evidence of more than one litter per year, and young did not reproduce in their year of birth. Adults stored fat in August, entering hibernation in late August or early September. The species has a restricted distribution in this area, and apparently occurs in isolated groups.

Introduction

Manitoba lies at the extreme northwestern limit of the range of *Napaeozapus insignis* (Miller) and to our knowledge only two specimens have been reported from the province (Soper, 1937, 1938). We report data from an additional 27 specimens, 26 of which were captured by us and one by C. H. Buckner.

Methods

During the summers of 1967-1971, the area controlled by the Whiteshell Nuclear Research Establishment of Atomic Energy of Canada Limited (Figure 1) was systematically sampled to determine the occurrence, distribution and abundance of small mammals. Lines of snaptraps were set for three nights in habitats including open field, deciduous forest and coniferous forest. Methods used and habitats sampled are described in Adam and Iverson (1968).

Ecological data taken at each trapping station included: 1) slope direction 2) slope inclination 3) distance to permanent water 4) identification of 5 closest trees and 5 closest shrubs 5) estimation of dominant vegetation (any species subjectively estimated to comprise more than 15% of the vegetation present) 6) visual estimation of percentage ground cover 7) estimation of canopy cover by the moosehorn method (Robinson, 1947).

Results and Discussion

Capture locations of all known Manitoba specimens of *N. insignis* (Figure 1) fall within the general area of distribution as shown by Hall and Kelson (1959). Soper's initial specimen was identified as *N. i. frutectanus* (Jackson) by R. M. Anderson (Soper, 1937), and a recent study by Wrigley (in press) concurs.

Morphology

Comparisons with previously reported measurements of this subspecies (Jackson, 1919, 1961; Surber, 1923; Soper, 1937, 1938; Gunderson and Beer, 1953; Burt, 1957; Wrigley, in press), from locations southeast of Manitoba, showed little difference in body measurements. However, tail lengths exceeded published ranges. The white tail tip, a diagnostic character of the genus, varied from 3 to 28 mm, but a comparison of means for each sex indicated the length of the white portion is not sex specific (Table 1). Similar results have been reported for other subspecies (Preble, 1938; Foster, 1947).

Mean adult weights, 23.3 g for males and 25.1 g for females, are misleading unless the capture date is taken into consideration. *Napaeozapus,* a hibernator, shows late-summer weight gains, but heavier individuals probably enter hibernation first, influencing actual popu-

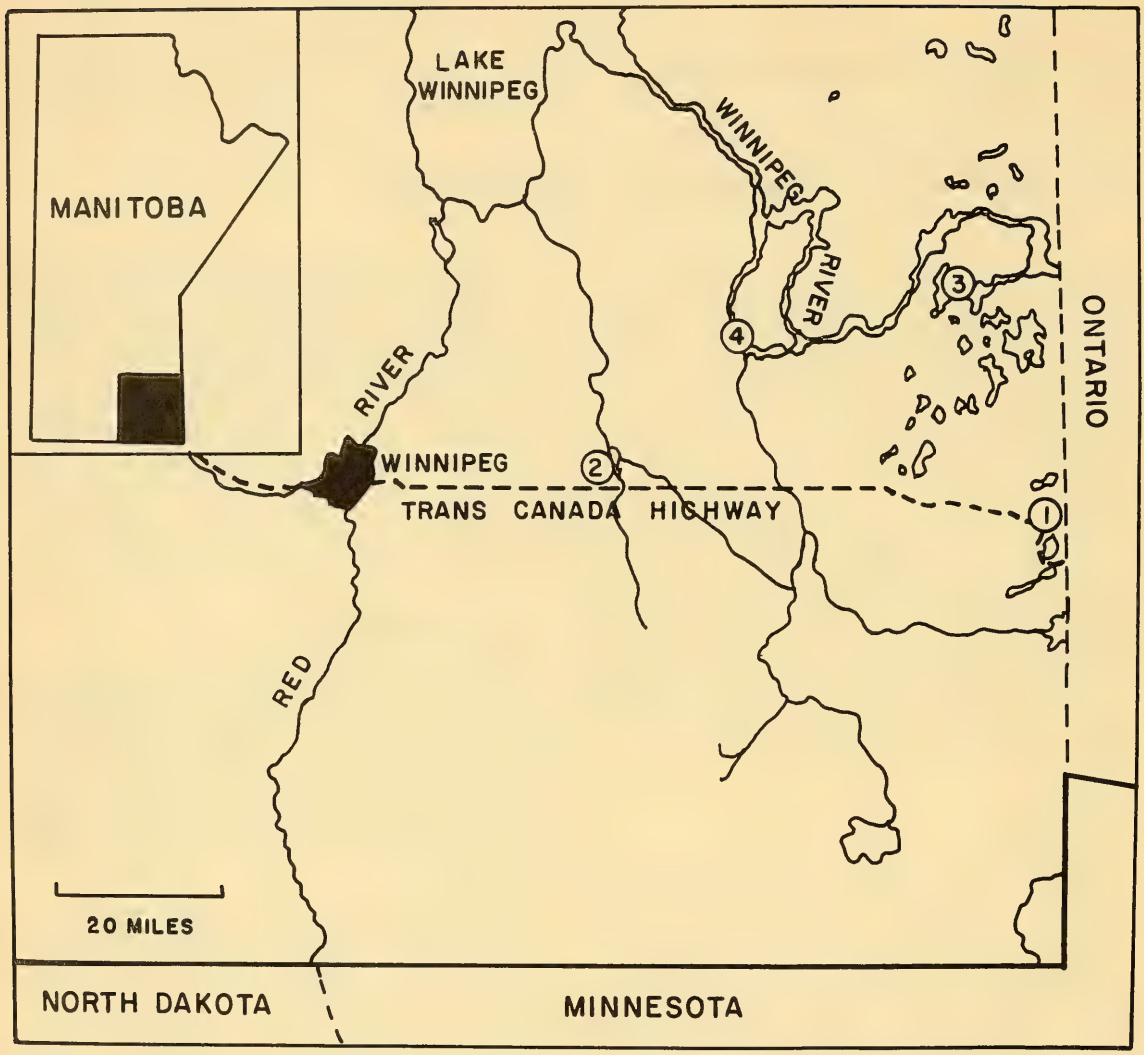

FIGURE 1. Capture locations of Manitoba specimens of *Napaeozapus*: 1. Caddie Lake (Soper, 1937) 2. Cedar Lake (Soper, 1938) 3. Forbes Lake (Buckner, collection number 159). 4. Whiteshell Nuclear Research Establishment.

lation means. Only 5 young, ranging in weight from 11.3-23.3 g, were captured.

Natural History

Males were in reproductive condition in late May and early June, as evidenced by testis lengths and positive epididymal smears. By July, testis lengths had decreased and fewer sperm were present. Only 2 females were caught in June. One was in an early stage of pregnancy, whereas the other had already littered. Small embryos were recorded in an early July specimen, indicating littering occurred until at least mid-July. No young animals were in reproductive condition. These data suggest only one litter per year, with young animals not breeding during the summer of birth.

Capture dates indicate a short period of activity for Manitoba *Napaeozapus*. No animals were captured during the last 2 weeks of April

TABLE 1. — Measurements for all known Manitoba specimens of *Napaeozapus*, including Soper's 1937 and 1938 specimens. Means are given with the range in parentheses. Lengths are in mm, weights are in g.

	Number	Total Length	Tail Length	Hind Foot	Ear	White Tail Tip	Weight
Adult Males	16	240.3 (228–254)	149.1 (139–160)	32.0 (30–34)	16.3 (14–19)	18.2 (10–27)	23.3 (18.4–29.5)
Subadult Males	2	221.0 (220–222)	140.5 (138–143)	31.0 (30–32)	15.5 (15–16)	14.0 (11–17)	21.0 (18.6–23.2)
Adult Females	8	243.0 (232–249)	148.5 (144–153)	31.8 (31–33)	16.4 (14–18)	18.1 (3–28)	25.1 (19.0–35.2)
Subadult Females	3	211.7 (210–214)	143.3 (142–145)	31.0 (30–32)	14.3 (14–15)	14.3 (10–17)	12.9 (11.3–16.0)

in 540 trap-nights in suitable habitat, nor in the first 8 days of May in 720 trap-nights. Three specimens resulted from 360 trap-nights in the last week of May. However both of Soper's (1937, 1938) specimens were captured earlier in May, approximately 20 miles south of our location. Males appear to emerge earlier from hibernation than females (5 males captured in May *vs.* no females), as noted by Preble (1956) and Wrigley (in press). Our latest capture date was 31 August, but suitable habitat was not trapped intensively enough to demonstrate that *Napaeozapus* is not active in September.

An examination of adult weight does not demonstrate a late-summer weight gain, although autopsy notes recorded abundant subcutaneous fat in late July and August specimens. The increasing weight of young, however, is evident from our small sample.

Habitat

All habitats snaptrapped 1967-71 were partitioned into one of three basic types, and the numbers of *N. i. frutectanus* caught in each type were totalled. No specimens were taken in 16,500 open field or 18,240 coniferous forest trap-nights. All 26 specimens were taken in deciduous forest near water (9,600 trap-nights), as opposed to deciduous forest far from water (24,000 trap-nights). No coniferous forest or open field near permanent water was trapped.

An examination of vegetational composition of capture locations showed coniferous trees were present less than 2% of the time (Table 2). Soper's (1937, 1938) specimens were taken in moist coniferous forest, and Wrigley (in press) suggests the spruce-fir association is the characteristic habitat for this species in the north. Our failure to capture any woodland jumping mice in over 18,000 trap-nights in coniferous forest, much of it moist, indicates that deciduous forest is preferred in our area.

The most common shrub was hazelnut, and 6 other genera occurred about equally (Table 2). Hazelnut was dominant at 71.4% of the capture locations, with strawberry the most common dominant herb. Dense ground cover is apparently not a necessity, for ground cover estimates at capture sites averaged only 52%. Canopy cover averaged 80.4%. Capture station vegetation was compared with that of unsuccessful stations on the same lines, but there were no significant differences. Jackson (1919, 1961), Gunderson and Beer (1953) and Burt (1957) suggested forests bordering streams were the preferred habitat of this subspecies. Soper's Manitoba specimens (1937, 1938) were from boreal forest with a sphagnum moss carpet, and Buckner's specimen was taken in the vicinity of a lake.

Numerous authors (Miller, 1893; Jackson, 1919, 1961; Soper, 1923, 1937, 1938; Snyder, 1924; Sheldon, 1934, 1938; Preble, 1956) have noted the proximity of a lake, stream,

TABLE 2. — Vegetation at locations where *Napaeozapus* was captured.

Closest trees	%	Closest shrubs	%	Dominant	%
Trembling aspen (*Populus tremuloides*)	25.7	Hazelnut (*Corylus cornuta*)	37.1	Hazelnut (*Corylus cornuta*)	71.4
Black ash (*Fraxinus nigra*)	22.9	Viburnum (*Viburnum* spp.)	14.3	Strawberry (*Fragaria virginiana*)	42.9
Balsam poplar (*Populus balsamifera*)	20.0	Rose (*Rosa* spp.)	12.9	Trembling aspen (*Populus tremuloides*)	35.7
Burr oak (*Quercus macrocarpa*)	15.7	Raspberry (*Rubus idaeus*)	7.1	Black ash (*Fraxinus nigra*)	28.6
American elm (*Ulmus americana*)	7.1	Saskatoon (*Amelanchier* spp.)	7.1	Burr oak (*Quercus macrocarpa*)	14.3
Paper birch (*Betula papyrifera*)	5.7	Mountain maple (*Acer spicatum*)	7.1	Viburnum (*Vibrunum* spp.)	14.3
Box elder (*Acer negundo*)	1.4	Snowberry (*Symphoricarpos albus*)	5.7		
Balsam fir (*Abies balsamea*)	1.4	Dogwood (*Cornus rugosa*)	5.7		

spring or bog, to capture sites of this genus. However, an extensive study in New York (Brower and Cade, 1966) revealed no preference for habitats near water. Our data show that permanent running water was a maximum of 90 m away from any of our capture sites, with many of the locations on stream or river banks. The mean distance from water, the Winnipeg River or its tributaries, was 33.6 m. Sixteen of the 26 specimens were captured on a slope ($\bar{x} = 11.2°$) and the other 10 were taken a mean of 8.4 m from a slope. These data thus support published habitat descriptions of the proximity of permanent water to preferred homesites, and also show that in our area *Napaeozapus* is associated with slopes. Since the terrain in this area is basically level, the choice of a slope for a homesite is more conspicuous. It is also possible that slopes are extensively used for hibernation sites. Slope directions, mostly southwest, probably reflect the direction of flow of the Winnipeg River.

It is apparent from this study that Manitoba *Napaeozapus* can live in deciduous forest, but must have access to sloping ground and/or permanent water. Unfortunately we have been unable to find areas of suitable habitat where one of these factors is present, and the other not, so that their relative importance can be compared.

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Literature Cited

Adam, M. and **S. L. Iverson.** 1968. Occurrence and distribution of small mammals in the WNRE controlled area Pinawa, Manitoba. Atomic Energy of Canada Limited report AECL-3184: 1-29.

Brower, J. E. and **T. J. Cade.** 1966. Ecology and physiology of *Napaeozapus insignis* (Miller) and other woodland mice. Ecology 47: 46-63.

Burt, W. H. 1957. Mammals of the Great Lakes region. University Michigan Press, Ann Arbor. 246 p.

Foster, C. A. 1947. On tail color in *Napaeozapus*. Journal of Mammalogy 28: 62.

Gunderson, H. L. and **J. R. Beer.** 1953. The mammals of Minnesota. University Minnesota Press, Minneapolis. 190 p.

Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America. Ronald Press, New York. 2 volumes.

Jackson, H. H. T. 1919. The Wisconsin *Napaeozapus*. Proceedings of the Biological Society of Washington 32: 9-10.

————. 1961. Mammals of Wisconsin. University Wisconsin Press, Madison. 504 p.

Miller, G. S. Jr. 1893. A jumping mouse (*Zapus insignis* Miller) new to the United States. Proceedings of the Biological Society of Washington 8: 1-8.

Preble, N. A. 1938. Sexual dimorphism in *Napaeozapus*. Journal of Mammalogy 19: 254.

————. 1956. Notes on the life history of *Napaeozapus*. Journal of Mammalogy 37: 196-200.

Robinson, M. W. 1947. An instrument to measure forest crown cover. Forestry Chronicle 32: 222-225.

Sheldon, C. 1934. Studies on the life histories of *Zapus* and *Napaeozapus* in Nova Scotia. Journal of Mammalogy 15: 290-300.

———. 1938. Vermont jumping mice of the genus *Napaeozapus*. Journal of Mammalogy 19: 444-453.

Snyder, L. L. 1924. Some details on the life history and behavior of *Napaeozapus insignis abietorum* (Preble). Journal of Mammalogy 5: 233-237.

Soper, J. D. 1923. The rare *Napaeozapus insignis*. Journal of Mammalogy 4: 127.

———. 1937. *Napaeozapus* in eastern Manitoba. Journal of Mammalogy 18: 369.

———. 1938. Additional note on *Napaeozapus* in eastern Manitoba. Journal of Mammalogy 19: 108-109.

Surber, T. 1923. The occurrence of the woodland jumping mouse in Minnesota. Fins, Feathers and Fur 35: 106.

Wrigley, R. E. In press. Systematics and biology of the woodland jumping mouse, *Napaeozapus insignis*. Illinois Biological Monographs Number 47.

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Behaviour Associated with Mortality and Stress in Maternal-Filial Pairs of Barren-Ground Caribou

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Abstract. During June and July 1970 observations on the maternal-filial bond in barren-ground caribou (*Rangifer tarandus groenlandicus*) from the Kaminuriak population were made on the calving ground and summer range in the central Keewatin, Northwest Territories. Information on the persistence of maternal or filial attraction was obtained from five live cows with live calves, four live cows with dead calves, one dead cow and a live calf, and two dead cows with dead calves. The barren-ground caribou's practice of synchronized calving, followed within days by rapid movement from the calving ground, in large postcalving aggregations, demands a strong maternal-filial bond. A strong bond minimizes the possibility of permanent separation in large postcalving groups at a time when the calf needs frequent nourishment and the care of its dam.

Introduction

In June and July 1970 we studied the causes of mortality in newborn barren-ground caribou from the Kaminuriak population in central Keewatin, Northwest Territories. Figure 1 shows the home ranges of this population. We were able to obtain information on the maternal-filial bond in live pairs and after the death of one or both of a pair.

The strength of mother-young relationships is a much discussed subject and its value is readily recognized in all the higher forms of animal life. This is especially true for gregarious herbivores, polygamous pinnipeds, and colonial birds.

Maternal cervids and their newborn offspring form strong maternal-filial bonds, which persist during the period of rapid growth of the neonate. Young females generally remain longer with their dam than young males. Hawkins and Klimstra (1970) have shown that some female white-tailed deer (*Odocoileus virginianus*) stay in maternal groups for at least 4 years.

In 1970, most of the Kaminuriak caribou calved between latitudes 63°00′ and 63°40′ and longitudes 93°20′ and 95°00′. We spent 180 hours searching for dead calves from a Hiller 12-E helicopter, flying at low levels (30-100 m). When we spotted a dead caribou we landed and performed a necropsy. The time of death was determined from carcass temperature, degree of rigor mortis and decomposition of tissues, and presence and numbers of maggots.

Observations

June 14: A dam deserted her newborn female calf when the helicopter approached too close. The calf was in a bedded position; the cow faced it, bobbing its head and grunting. But the calf had just been born and could not follow. The cow ran off about 200 m and watched us inspect the calf. When we returned the next day the calf was gone.

June 14: A dam was standing over a stillborn male fetus, still in membrane, although it had been on the ground for several hours. As the helicopter approached closely, the cow departed and rejoined a postcalving group some 3 km away.

June 17: An adult female and her male calf were dead (Figure 2) – the dam on its left side, legs fully extended and rigid; the calf curled up behind the mother's forelegs. The dam had died from a massive abdominal hemorrhage resulting from a ruptured uterus. The calf had foraged near his dam for several days before succumbing to malnutrition. We found no traces of milk curds in its stomach.

June 19: A male calf (1-2 weeks old) was found dead, his dam was nearby. The calf had been dead for only several hours, the cause could not be detected. A pair of sandhill cranes (*Grus canadensis*) were repeatedly driving the

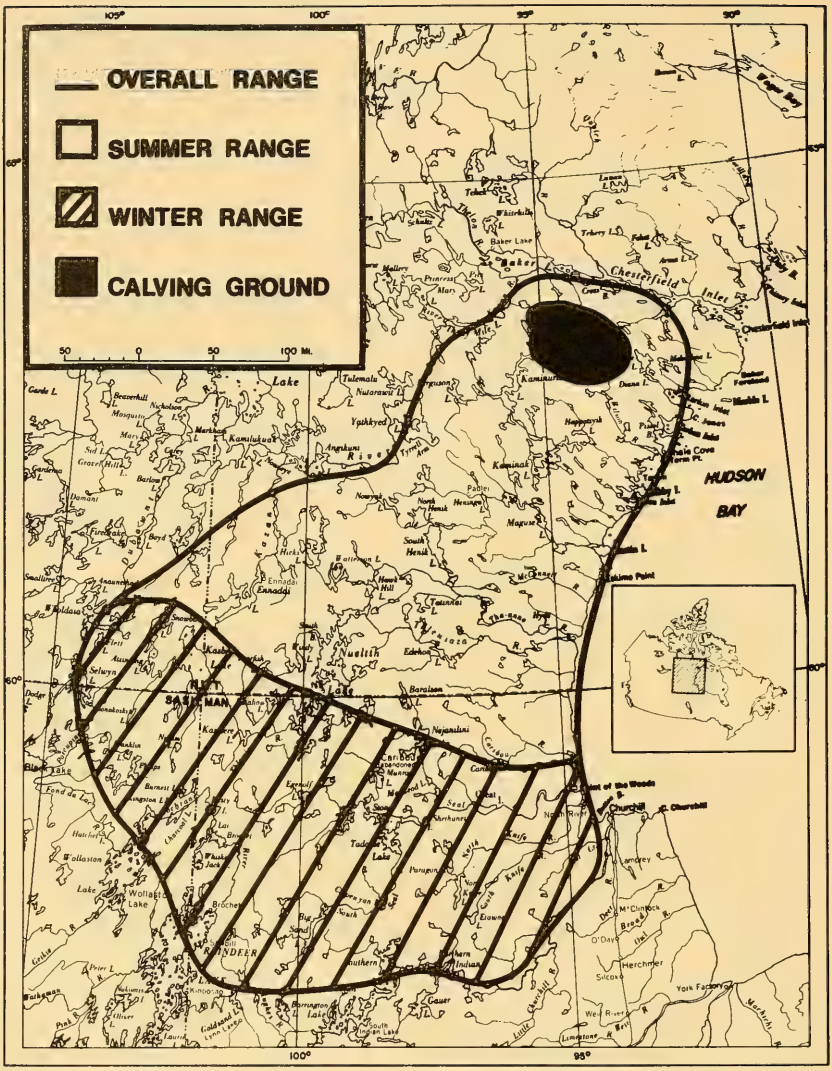

FIGURE 1. Home ranges of barren-ground caribou from the Kaminuriak population.

dam away from her dead young. Miller and Broughton (1970) have described the event in detail.

June 20: A male calf (1-2 weeks old) was too weak to travel with his dam. The dam stood over the calf, bobbing her head and grunting. We landed about 200 m away, walked to the pair and caught the calf, which was quite weak. It had great difficulty in getting to its feet and exhibited marked incoordination when it attempted to walk. The necropsy revealed no significant pathology in any of the organ systems. Brucellosis was suspected, but no primary pneumonia was found in the calf. The low level of brucellosis (4.37%) detected in the Kaminuriak population of barren-ground caribou (Broughton et al. 1970) would tend to exclude brucella infection as the cause of the calf's malaise. There was no milk in the abomasum. The calf's apparent failure or inability to nurse suggested that its dam might have had mastitis or might have been agalactic.

The cow had remained close by, we killed it and performed a necropsy. The dam had a heavy infection of *Cysticercus tenui collis* in the liver, metritis, hemorrhagic vaginitis, and necrotic vulvitis. Metritis and vaginitis may have interferred with the flow of milk for several days and the calf was then too weak to nurse, or the pressure on the udder may have made it tender and the cow would not let the calf nurse. We examined a milk sample bacteriologically and isolated hemolytic *Escherichia coli,* a cause of mastitis. The mastitis may have caused the calf to go off the dam's milk.

June 20: A female calf (1-2 days old) and its dam were dead. They were in the same position as the dead maternal pair we found on June 17 (see Figure 2). The presence of the retained placental tissues suggested that the cow had died within days after parturition from an undetermined cause. The dead calf had pneumonic patches in the lungs and no food items in its stomach. It had apparently survived for several days after the death of the dam.

June 22: A newborn calf and maternal cow were observed. The calf was too weak to stand and the cow had just finished cleaning it, when the helicopter approached. Thinking the calf dead, the pilot brought us too close to the cow. It stood its ground until we were within 50 m, ran off about 1 km, and did not return. We saw a second cow and a newborn calf too weak to stand 1 km to the west of the first pair. We kept about 200 m away and the cow remained with her calf.

June 26: A cow was dead; its live calf was nearby. We landed about 100 m away and walked to the carcass. The calf stayed several

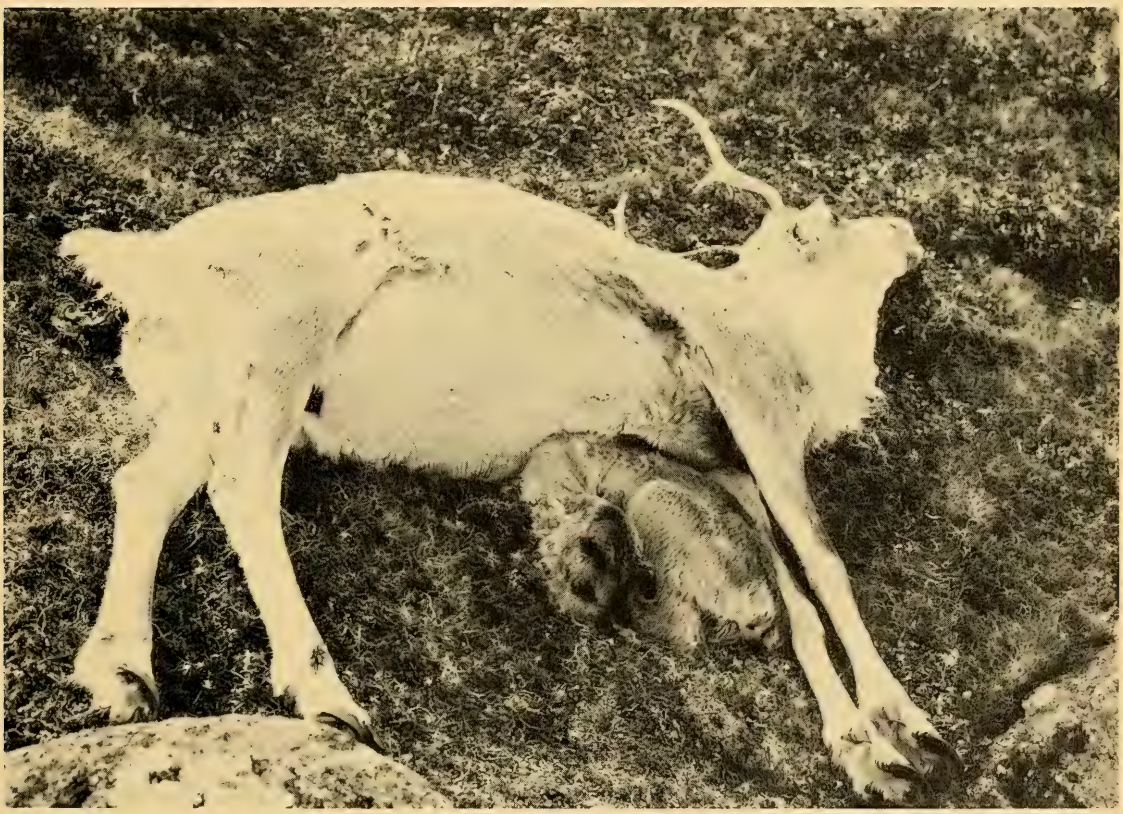

FIGURE 2. Dead maternal cow and calf. The cow died first and the calf remained by its dam and succumbed to malnutrition.

meters away, blatting and running back and forth constantly as we examined its dam. Necropsy of the carcass revealed bloody milk, extensive bruises and hemorrhages along the mid-dorsal line and the left side of the back, and generalized peritonitis. We found adhesions between the walls of the rumen and abdomen but no evidence of external penetration of the skin. The calf probably would not have survived so we killed and examined it. The calf was about 2 weeks old and in good physical condition. The stomach contained vegetation but no milk. The glucose-blood ratio was less than 45 mg per 100 ml, relatively low when compared to the values obtained for some young caribou held in captivity (Personal communication. Dr. E. H. McEwan, Canadian Wildlife Service, Zoology Vivarium, University of British Columbia, Vancouver).

July 4: A female calf (2-3 weeks old) was alive but too weak to get off her side. The dam stood grunting about 8 m away, its head bobbing, but moved off about 100 m as our helicopter approached. From that point, she frequently rushed in several meters, grunting loudly, then retreated, while we examined the calf. Necropsy of the calf revealed a massive abscess in the liver. The calf's lethargic condition was probably caused by a generalized toxemia resulting from toxins liberated from the abscess.

July 6: A wolf (*Canis lupus*) had killed a female calf over 3 weeks of age and was scared off when our helicoter approached. The carcass was still warm and its hemorrhagic condition indicated that the calf had been alive when attacked by the wolf. The dam was about 50 m to the east. She moved back and forth while watching us, then trotted off when we started the helicopter engine after finishing the necropsy.

July 9: A male calf (4 weeks old) was killed by a wolf that had rushed into a postcalving aggregation, scattering the caribou. As our helicopter came closer, the wolf ran off. We saw an adult cow, presumably the dead calf's dam, on the back trail of the caribou's line of escape. She was bobbing her head and grunting moving slowly back in the calf's direction.

Discussion

Newborn barren-ground caribou normally follow their dams within hours after birth, but some calves exhibit the "freezing" behaviour common to all other North American cervid neonates. When we approached some calves closely, they dropped or remained in a prostrate motionless position. de Vos (1960) stated that "freezing" did not occur in barren-ground caribou calves, but Lent (1966) reported it in newborn caribou disturbed within 48 hours of birth, although it was not consistent. The actions of the dam's head bobbing and grunting appear to be the stimuli which serve as releasers for following-behaviour in the newborn, a conclusion as also reached by de Vos 1960: 253, Pruitt 1960:31 and Lent 1966:733, 743-744.

Bonding between dam and calf serves to minimize the possibility of permanent separation in large postcalving groups at a time when the calf needs frequent nourishment and care from the dam. Lent (1966) reported that dams located and reclaimed their calves after separation caused by human activity. Banfield (1954) observed that maternal caribou were solicitous for their calves and seldom abandoned them. He noted that a dam remained near her dead calf, killed by a wolf, for two days. During the postpartum period cows and calves do not accept other calves readily (de Vos 1960:253, Pruitt 1960:33 and Lent 1966:733). Pruitt (1960:33), however, has observed that deprived cows will accept strange calves. The attraction between mother and young has survival value for the individual young therefore the species.

Conclusions

Our observations offer further evidence of strong maternal-filial bonds in barren-ground caribou. The greater reluctance of dams to desert older calves indicate strengthening of the maternal-filial relationship after several days of care-soliciting behaviour by the young and care-giving behaviour by the mother. Finally, the practice of synchronized calving, followed within days by rapid movement from

the calving areas, in large post-calving aggregations, demands a strong maternal-filial bond in the species.

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Literature Cited

Banfield, A. W. F. 1954. Preliminary investigation of the barren-ground caribou. Canadian Wildlife Service, Wildlife Management Bulletin, Series 1, Number 10B, 112 pp.

Broughton, E., L. P. E. Choquette, J. G. Cousineau, and **F. L. Miller.** 1970. Brucellosis in Reindeer, *Rangifer tarandis L.,* and the migratory barren-ground caribou, *Rangifer tarandus groenlandicus* (L.), in Canada. Canadian Journal Zoology 48 (5): 1023-1027.

de Vos, A. 1960. Behavior of barren-ground caribou on their calving grounds. Journal of Wildlife Management 24 (3): 250-258.

Hawkins, R. E., and W. D. Klimstra. 1970. A preliminary study of the social organization of white-tailed deer. Journal of Wildlife Management 34 (2): 407-419.

Lent, P. C. 1966. Calving and related social behavior in the barren-ground caribou. Zeitschrift für Tierphysiologie 23 (6): 701-756.

Miller, F. L., and **E. Broughton.** 1970. An unusual display of territorial aggressiveness by sandhill cranes (*Grus canadensis Linné*). Canadian Field-Naturalist 85 (1): 66-67.

Pruitt, W. O., Jr. 1960. Behavior of the barren-ground caribou. Biological Papers University of Alaska 3: 1-44.

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The Spread of *Vincetoxicum* Species (Asclepiadaceae) in Ontario[1]

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Abstract. Two weedy species of *Vincetoxicum, V. medium* and *V. nigrum,* are being encountered with increasing frequency as naturalized species in Ontario. A third species, *V. album,* has not been reported in recent years.

The genus *Vincetoxicum* Moench includes three species which have become naturalized in North America: *V. album* (Mill.) Aschers., *V. medium* (R. Br.) Decne., and *V. nigrum* (L.) Moench. In most North American manuals, e.g., Fernald (1950) and Gleason & Cronquist (1963), these species are listed under *Cynanchum.* Studies of the Asclepiadaceace on a world-wide basis have convinced Bullock (1958) that *Vincetoxicum* should not be included in *Cynanchum,* but that the latter name should be restricted to a group of species in the Southern Hemisphere, none of which is naturalized in Canada. Bullock's (1958) studies have also established that the generic name *Vincetoxicum* is correctly applied to the species discussed in this paper, rather than to the angle-pods (correctly, *Gonolobus* Michx.), with which this name was once associated. The present use of the name *Vincetoxicum* is currently widely followed in Europe, and prevailed in North America throughout the nineteenth century. The treatment of *Vincetoxicum* as a genus separate from *Cynanchum* avoids the nomenclatural problem of the illegitimacy of the name *Cynanchum nigrum* (L.) Pers., noted by Monachino (1957).

Plants of these *Vincetoxicum* species are herbaceous perennials which, when the stems have attained sufficient height, become twining vines. The leaves range from ovate to cordate, and are smooth, glossy, and dark green, with entire margins. The flowers are borne in cymes terminating axillary penduncles. The corollas are star-shaped, with five spreading lobes. The fruits and seeds are similar to those of *Asclepias* species. The two species now naturalized in Ontario, *V. medium* and *V. nigrum,* are illustrated in Figure 1, and have been contrasted in detail by Moore (1959). As *Cynanchum* species, they are also contrasted in Gleason & Cronquist's (1963) Manual. *Vincetoxicum album,* as *Cynanchum vincetoxicum,* is briefly described and distinguished from *V. (C.) nigrum* in the eighth edition of Gray's Manual (Fernald, 1950).

In the present study, it was found that some fruiting specimens could not be identified with certainty from traits of gross morphology alone. The identity of such specimens was checked through the use of cuticular imprints from the lower leaf surfaces. *Vincetoxicum nigrum,* which has twice the chromosome number of *V. medium* (Moore, 1959), has considerably larger guard cells than those of *V. medium.*

Only a relatively few colonies of *Vincetoxicum* species have thus far been reported in North America. This paper is designed to update information on the extent to which these species have spread in Ontario, and to provide a basis of comparison for future studies of the naturalization of these species. Notes on the local establishment and expansion of colonies, based on observations in the Hamilton area, have been included to demonstrate the weediness and potential nuisance value of these species.

Vincetoxicum nigrum was the first of these species reported to have become naturalized in North America. Its spread on this continent is chronicled in the successive editions of Gray's Manual of Botany, from the fifth (Gray, 1867), in which it was said to occur in "Cambridge,

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FIGURE 1. *Vincetoxicum* species. a-d, *V. medium*. a, portion of upper part of stem, bearing two cymes, with flower buds, open flowers, and young fruits. b, fruits in late autumn, after dehiscence. c, leaves on lower part of stem. d, flower. e, *V. nigrum*, flower.

Mass., &c.: a weed escaping from gardens", to the eighth (Fernald, 1950), in which its North American range was given as "Waste places, roadsides, thickets and fields, Me. to O., Pa. and Kans. (Natzd. from Eu.)." As Monachino (1957) later pointed out, the *"Cynanchum nigrum"* of Fernald (1950) consisted in part of the species now called *V. medium,* but examination of specimens in herbaria in the United States indicates that *V. nigrum* is the more widely distributed species there. When the status of this genus in Canada was reviewed by Moore in 1959, the only locality in this country where *V. nigrum* was known to have escaped from cultivation was near the arboretum of Notre Dame College in Montreal, Quebec (1949).

Vincetoxicum nigrum had been collected at two Ontario localities, both in Northumberland County, prior to Moore's study, but at that time the specimens were still unidentified. The earliest Ontario collection of this species is from

Grafton, where it was found by Mrs. C. W. Dickson in 1952 (*Dickson 418,* OAC[2]). In 1956 *V. nigrum* was collected by Percy Gooding at Hilton, ca. 13 mi northeast of Grafton (*Gooding 1859,* DAO, OAC).

Seed of *V. nigrum,* which had been received as seed of *Periploca graeca* L. (a woody asclepiadaceous vine not occurring as a wild plant in Canada), was planted at the Royal Botanical Gardens lath house, in West Flamborough Township, Wentworth County, in 1955. This species has subsequently spread throughout the lath house and into adjacent beds of ornamentals, becoming a weed. In 1969, it was discovered by James Spaxman in the R.B.G. nursery, ca. 0.5 mi from the lath house, where it had evidently been present at least since the previous year. Here *V. nigrum* was found along a lane and among dwarf conifers, with which it had probably been inadvertently transplanted from the lath house (*Pringle 1126,* HAM, LKHD, OS). Additional colonies were found in the nursery in 1970.

The earliest of several collections of *V. nigrum* from Kingston, Frontenac County, was made in 1961 by Marlene Forrester, who found this species "growing wild on a fence" along King Street (*Forrester 1741,* QUK). C. H. Zavitz collected *V. nigrum* in a hedge on Stuart Street in 1965 (*Zavitz 1215,* TRT). In 1966, he made additional collections on the Queen's University campus (*Zavitz 1549,* CAN) and on a fence at the junction of Union Street and Palace Road (*Zavitz 1474,* DAO). On the labels of these specimens, he suggested that *V. nigrum* might have escaped from the Botanic Garden which formerly existed at Queen's University. In 1964, W. G. Dore had noted on the label of a collection of *V. nigrum* from the junction of Stuart Street and University Avenue (*Dore & Savile 20798,* DAO): "It has probably been here for several years judging from its local dispersion, but not likely prior to 1937 when I taught 'Local Flora' at Queen's Summer School." In 1967, however, Dore noted that George Lawson, who had established the Botanic Garden at Kingston, had listed (ms. quoted by Dore, 1967) among the plants in this garden: *"Periploca Graeca* — spontaneous; — perhaps brought in soil from the Bot. Gard., Cambridge, Mass." Since the Botanic Garden was founded in 1861, and Lawson left Kingston in 1863 (Dore, 1967), the appearance of *"Periploca Graeca"* must have occurred during the period 1861-1863. Dore then recorded his suspicion that Lawson's *"Periploca Graeca"* was actually *"Cynanchum nigrum, . . .* which now infests fence rows in the neighbourhood." In Lawson's time, *Vincetoxicum* (by any name) had not yet been listed in North American floras, but *Periploca graeca* was included. It would scarcely have been extraordinary, therefore, for *V. nigrum* to have been identified as *P. graeca* at that time. Moreover, it seems significant that shortly thereafter, *V. nigrum* was recorded by Gray (1867) as having escaped from cultivation in Cambridge, Massachusetts, while *P. graeca* was still known as a naturalized species only in New York State. It appears probable, therefore, that the present colonies of *V. nigrum* in Kingston are derived from an inadvertent introduction to the Botanic Garden, as Zavitz suspected, despite the absence of records for the period between 1863 and 1961.

Vincetoxicum nigrum has also become established as a wild plant in Glengarry County, where G. N. Gogo discovered "a large, dense patch" in a ditch and along a fence by Highway 2, 1 mi east of Glen Walter, in 1964 (*Gogo 562A, 734, Dore & Gogo 21448,* DAO). In 1969, a second colony was discovered in this county, in a brushy pasture ⅜ mi east of the previously known population (*Gogo in 1969,* DAO).

Vincetoxicum album was listed by Fernald (1950) as having escaped from cultivation only in western New York and southern Ontario. The first report for Ontario was published by J. M. Macoun (1906) on the basis of a specimen of this species collected at Niagara Falls, by William Scott in 1904 (TRT). *Vincetoxicum album* has apparently not been collected subsequently in Ontario.

[2]Standardized herbarium designations follow Lanjouw & Stafleu (1964), with the addition of LKHD for the herbarium of Lakehead University, Thunder Bay, Ontario.

Previously, Cameron (1894) had listed *V. nigrum* among the plants occurring in Queen Victoria Park at Niagara Falls. In the absence of specimens, it is not certain whether *V. nigrum* had in fact become established at Niagara Falls in 1894, or whether this report was actually based on the colony of *V. album* which was later discovered by Scott, since *V. album* was not listed in North American manuals in Cameron's time. No species of *Vincetoxicum* have been encountered in more recent studies of the flora of the Niagara Falls area (Yaki, 1970, and references cited therein).

Vincetoxicum medium was first recorded as a naturalized species in North America in 1957, when Monachino (1957) reported that specimens from New York and Pennsylvania, dating back to 1929, actually represented this species, although they had hitherto been identified as *V.* (or *C.*) *nigrum*. Shortly thereafter, Moore (1959) reported that this species was also naturalized in Canada, and that here, too, it had been confused with *V. nigrum*.

Thus far, Ontario remains the only province from which *V. medium* has been recorded as a wild plant, assuming that a specimen collected in 1885 from "cultivated ground" in Victoria, British Columbia (*Fletcher, B. C. Geol. Survey 16054,* CAN), represents an intentional planting which did not persist (see Moore, 1959). The earliest collection in Ontario was made near Toronto Junction, by Mrs. J. E. White in 1899 or possibly 1889. The date appears as 1889 in Moore's (1959) article on this genus in Canada, and as 1899 in a letter from Moore quoted by Monachino (1959). The specimen in question could not be located during this study. Since other specimens of *V. medium* in DAO were collected at Toronto Junction by Mrs. White in 1902, the later date, 1899, seems more certainly to have been within the period of her collecting activity in the Toronto area.

Numerous additional collections of *V. medium* have been made within the Don River watershed in Metro Toronto. Dates on specimens in CAN, DAO, HAM, OAC, and TRT range from 1902 to 1971. Locality data include: York Mills; Wexford; along Don River near Lawrence Avenue; Wilket Creek; Sunnybrook Park; Serena Gundy Park; Sherwood Park; Don Valley; Donlands; and near Radio Station CHUM. *Vincetoxicum medium* has become abundant over extensive portions of the Wilket Creek – – Sunnybrook — Serena Gundy parks system, forming large, dense stands along the edges of thickets and on sunny hillsides, and occurring more sparsely in wooded areas.

Vincetoxicum medium has also been collected on White Road, Dunbarton, Ontario County, a short distance east of the Metro Toronto boundary, in 1952 and 1953 (*Shumovich 1,* OAC, and *345,* DAO). Yet another collection from the Toronto area consists of presumably spontaneous plants from "Mr. Myall's garden, Thistletown" in what is now the northwestern part of Metro Toronto (*Gravatt in 1957,* TRT). In 1963, *V. medium* was collected on Snake Island in Lake Simcoe, in the northern part of York County (*Dumais & Edmunds 187,* TRT). Data on the extent of these populations are not available.

Vincetoxicum medium has been encountered as a naturalized species in Ottawa since 1931, when the first collections were made near the Chemistry Building (now an Animal Research Institute Building) on the Central Experimental Farm (*Ritchie in 1931,* DAO). In 1959, Moore reported that this species "now persists tenaciously in the Central Experimental Farm area on hedges and in ornamental beds within a radius of about half a mile from the Chemistry Building." In 1967, a colony of about 50 plants of *V. medium* was found by W. G. Dore and R. J. Moore in unkempt yards and along a fence at the end of Galt Street, Ottawa, 0.86 mi from the nearest plants on the Central Experimental Farm (*Dore & Moore 22871,* DAO). This colony was then estimated to be about 5 or 6 years old. Another Ottawa specimen, from the garden of Dr. A. E. Porslid, collected in 1962 (*Porsild 23130,* CAN), presumably represents cultivated plants.

A clue to the origin of the *V. medium* populations in Ottawa appears in W. T. Macoun's (1908) list of herbaceous perennials tested in the Aboretum and Botanic Garden at the Central Experimental Farm. Here it is recorded that *"Vincetoxicum nigrum"* was planted in 1905 for

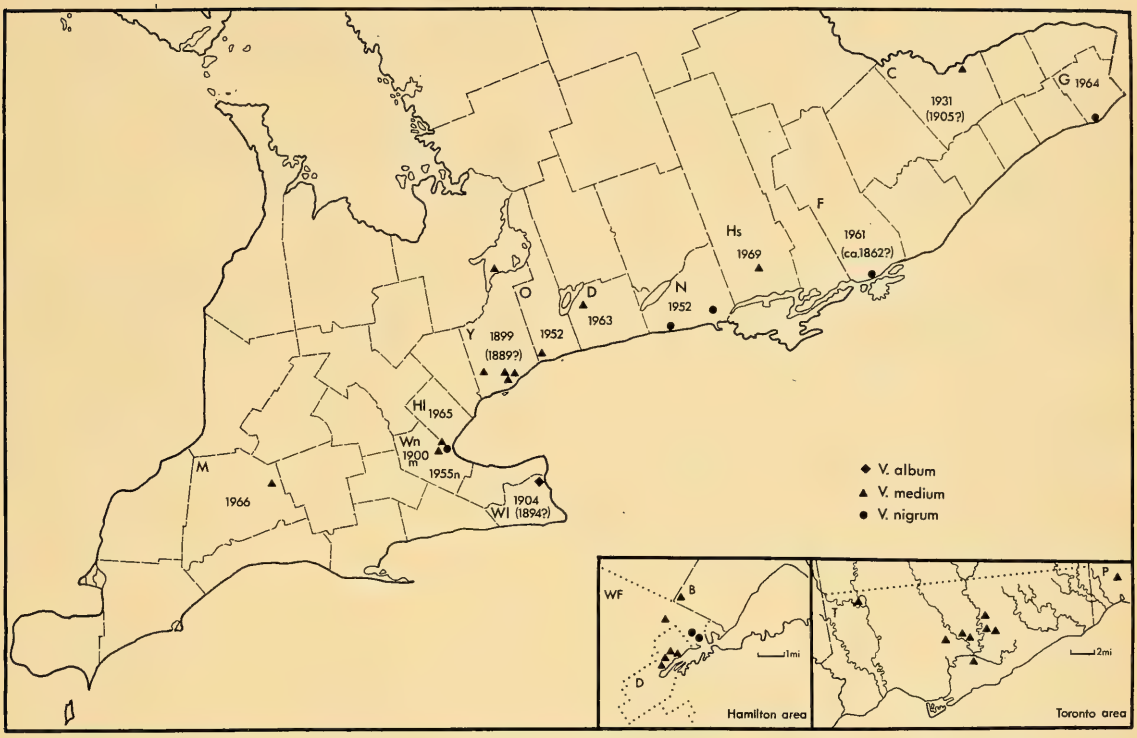

FIGURE 2. Distribution records of *Vincetoxicum* species naturalized in Ontario. Dates indicate earliest records of the species in each county, regardless of status. Counties, main map: C, Carleton; D, Durham; F, Frontenac; G. Glengarry; Hl, Halton; Hs, Hastings; M. Middlesex; N. Northumberland; O, Ontario; Wl, Welland; Wn, Wentworth. Municipalities, inset maps: B. Burlington; D. Dundas; P, Pickering Township; T, Metropolitan Toronto; WF, West Flamborough Township.

evaluation as an ornamental perennial. It seems quite possible that it was actually *V. medium* which was planted, and that the populations of *V. medium* later found in Ottawa spread from this introduction.

Vincetoxicum medium was found in Cartwright Township (near Burketon), Durham County, in 1963 (*Kirk 6834,* CAN, TRT). This population, when visited by the author in 1971, consisted of a large colony in a moist opening among white cedars, with a smaller colony on a hilltop a short distance away (*Pringle 1287*, HAM, OAC). The density of *V. medium* in the less heavily shaded parts of the main colony was sufficient to exclude almost all other vegetation, except for a few raspberry canes. In more densely shaded sites, the stems of *V. medium* were less crowded but still numerous, climbing to a height of 2 m on the cedars.

One plant of *V. medium* was found by Clarence Frankton in a low field near the Thames River north of Thorndale, Middlesex County, in 1966 (*Frankton 1941,* DAO).

At Latta, in Hastings County, R. Hainault and I. D. Macdonald found *V. medium* present in "large colonies on both sides of the road" (*Hainault & Macdonald 4979,* CAN). The extent of this population indicates that it must have been established for several years prior to its discovery.

The earliest record of *V. medium* in the Hamilton area is a specimen in TRT collected by William Scott in 1900. The locality is given merely as "Hamilton", with no indication as to whether the specimen represents a wild or cultivated plant. No further collections of *V. medium* were made in this area until 1965, when two specimens were brought to the author for

identification. The first was found by Rachel McLeod and Barbara Pickersgill along the Bruce Trail just southeast of Clappison's Corners, Halton County (*McLeod & Pickersgill in 1965,* HAM). In 1969, the population at this site consisted of only a few scattered plants, growing on a shaded talus slope (*Pringle 1125,* HAM, MICH).

A second population was discovered by W. J. Lamoureux on property recently acquired by the Royal Botanical Gardens, along Patterson Road, West Flamborough Township, Wentworth County. A large, dense stand is present on brushy slopes between the north side of the road and the base of the Niagara Escarpment, indicating by its extent that this population has been established for many years (*Pringle 1111,* HAM, LKHD, OAC, OS). Only a few plants were found in the cow pasture on the south side of the road (*Pringle 1119,* HAM).

Four small colonies of *V. medium* have been discovered since 1968 in the Coote's Paradise Sanctuary of the Royal Botanical Gardens, Wentworth County, in sites which had been well known to the author for several years. Because these colonies had not been observed on previous visits to these sites, and had not been reported in any of the earlier floristic surveys of the Gardens' natural areas, it seems highly probable that they are of recent origin. During the last several years, a number of new truck and foot trails have been constructed in the northwestern part of Coote's Paradise Sanctuary, and it seems likely that the increased pedestrian traffic and use of equipment in this area has contributed to the spread of *V. medium.* These new colonies have been observed at frequent intervals in order to determine their rates of expansion.

The first of these colonies was discovered in the winter of 1968-1969, in a disturbed area along a truck trail constructed in 1967, ca. 2.0 mi southwest of the large population on Patterson Road. At that time there were seven aerial stems in this colony. The following summer, over 100 aerial stems were present (*Pringle 1127,* DAO, HAM, KE). Only slight increases in the extent of this population were noted during the next two years. The number of aerial stems had increased to about 200 in 1971, but the population as a whole appeared less vigorous. Since growth of *V. medium* is generally densest in relatively open habitats, it appears likely that the increasing growth of sumac and goldenrod at this site had been detrimental to the *Vincetoxicum* population.

Another colony of *V. medium* was found in 1970, in an abandoned field near the edge of the "Hydro Pond", ca. 0.5 mi west of the colony mentioned above (*Pringle 1257,* HAM). This population consisted of two mature plants, which had evidently flowered in 1969 and 1970, along with numerous small plants which appeared to be seedlings. This site differs from the one beside the truck trail in that no major disturbance of the soil or vegetation has occurred in recent years. Little change was observed in this colony in 1971.

A third newly established colony on the Gardens' properties is located adjacent to a trail shelter ca. 1.4 mi south of the Patterson Road population and 0.5 mi east of the truck-trail colony (*Pringle 1258*, HAM). This colony consisted of two plants, which appeared to be in their second or third year, in 1970. Four plants were present in 1971. Most recently, a solitary, vigorous plant of *V. medium* was found in 1971 in a grassy opening in the Reforestation Area, about midway between the truck-trail and Hydro Pond colonies.

Although *V. medium* and *V. nigrum* were slow in becoming established in Ontario, and are still uncommon species in this province, the above data indicate that their rate of establishment in new localities has been increasing in recent years. It seems highly probable that more populations of *V. medium* and *V. nigrum* will continue to be found in Ontario, and that these species will be reported from additional provinces and states. From herbarium labels, published reports and the author's observations, it is also apparent that these species, once established in a locality, are likely to form large, dense populations and to spread to additional sites nearby, and should therefore be regarded as potentially troublesome weeds.

Literature Cited

Bullock, A. 1958. Nomenclatural notes: X. On the application of the name *Vincetoxicum*. Kew Bulletin 13: 302.

Cameron, R. 1894. Catalogue of Plants of Queen Victoria Park. Ontario Government Publication, Toronto.

Dore, W. G. 1967. Canada's first botanic garden. Greenhouse-Garden-Grass 6(2): 6-14.

Fernald, M. L. 1950. Gray's Manual of Botany, ed. 8. American Book Company, New York.

Gray, A. 1867. Manual of the Botany of the Northern United States . . . , ed. 5. Ivison, Blakeman, Taylor, & Company, New York.

Gleason, H. A. and **A. Cronquist.** 1963. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. D. Van Nostrand Company, Princeton.

Lanjouw, J. and **F. A. Stafleu.** 1964. Index herbariorum. Part I: The herbaria of the world, ed. 5. Regnum Vegetabile Vol. 31.

Macoun, J. M. 1906. Contributions to Canadian botany. XVII. Ottawa Naturalist 20: 162-172.

Macoun, W. T. 1908. List of herbaceous perennials tested in the Arboretum and Botanic Garden, Central Experimental Farm, Ottawa, Canada, with descriptions of flowers, and other notes. [Central Experimental Farm] Bulletin No. 5. Second Series.

Monachino, J. 1957. *Cynanchum* in the New York area. Bulletin of the Torrey Botanical Club 84: 47-48.

Monachino, J. 1959. Supplementary notes on *Cynanchum*, *Elscholtzia* and other local plants. Bulletin of the Torrey Botanical Club 86: 201-203.

Moore, R. J. 1959. The dog-strangling vine *Cynanchum medium*, its chromosome number and its occurrence in Canada. Canadian Field-Naturalist 73: 144-147.

Yaki, G. J. 1970. Plants of the Niagara Peninsula. Special Publication No. 2, Niagara Falls Nature Club.

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The Birds of the Holman Region, Western Victoria Island

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Abstract. Forty-eight species of birds (eight hypothetical) are listed as occurring in the Holman area on western Victoria Island. Three anseriform species, Mallard, Shoveler and White-winged Scoter, are reported for the first time from Victoria Island although the latter two must be listed as hypothetical. Two passerine species, White-crowned Sparrow which was positively identified and Rusty Blackbird which is tentatively listed, are new reports and northern range extensions.

Introduction

This paper results from observations made during a ringed seal population study in the Holman area carried out under the auspices of the Arctic Biological Station, Fisheries Research Board of Canada. The area was considered important as an observation point for birds because of the diversity of species, the fact that only two short studies had been made there previously (Porsild, 1951, Höhn, 1955), and because it is an area coinciding with the possible range limits of both eastern and western dispersing species. A number of detailed bird studies have been made all around this area. Macpherson and Manning (1959), and Parmelee, Stephens and Schmidt (1967) describe the birds of the Adelaide Peninsula and southeastern Victoria Island, thus identifying most of the eastern faunal components of the present area. Manning, Höhn and Macpherson (1956) give a detailed list of birds of Banks Island immediately to the west. Prince Patrick Island (MacDonald, 1954) to the northwest and Cornwallis Island (Geale, 1971) to the northeast, have also been studied in detail.

Narrative

Figure 1 shows the area covered in this study. The period 12 March to 16 May, 1971 was spent hunting along the floe edge situated one to 20 miles from land, along the coast from Nunungiak, in Prince Albert Sound, and north to Berkley Point. 17 May to 20 May was spent travelling over the ice and land to Sachs Harbour on the west coast of Banks Island. The return journey was made from 24 to 27 May. On 4 June a permanent seal hunting camp was established at Malinik. Travel, from this date on, was by 22 foot freighter canoe. Most travel during this period was concentrated between Malinik and Nunungiak along the ice edge with the occasional trip to Holman. On 6 July the camp was moved to Koaraokat. The period 9 July to 16 July was spent travelling and hunting in Minto Inlet. On 16 July the camp was moved to Pitotak. The ice between the islands and mainland of Prince Albert Sound began to drift out at this time, and from this date on, the main area of travel was between Pitotak and Hinigyoak in Prince Albert Sound.

The period from 8 August to 15 September was spent away from the Holman area. From my return until departure on 13 October travel was concentrated in the Tahiuyak area of Prince Albert Sound.

Except for occasional inland journeys during March for caribou hunting, and a few short inland walks in the summer around the village of Holman, the only occasions for overland travel were the trips across Banks Island in May, and a walking trip into Tatik Lake, from Kurdjuak in Minto Inlet, during July.

In 1972 most observations were made around our camp at Iluvilik. Some sightings were made on adjacent islands and in the Tahijuak area of Prince Albert Sound.

Results

The present study lists the bird species seen between 12 March and 13 October 1971 and between 25 May to 28 June, 1972. Since most of this period was spent along the coast it is very likely that some rarer inland species were

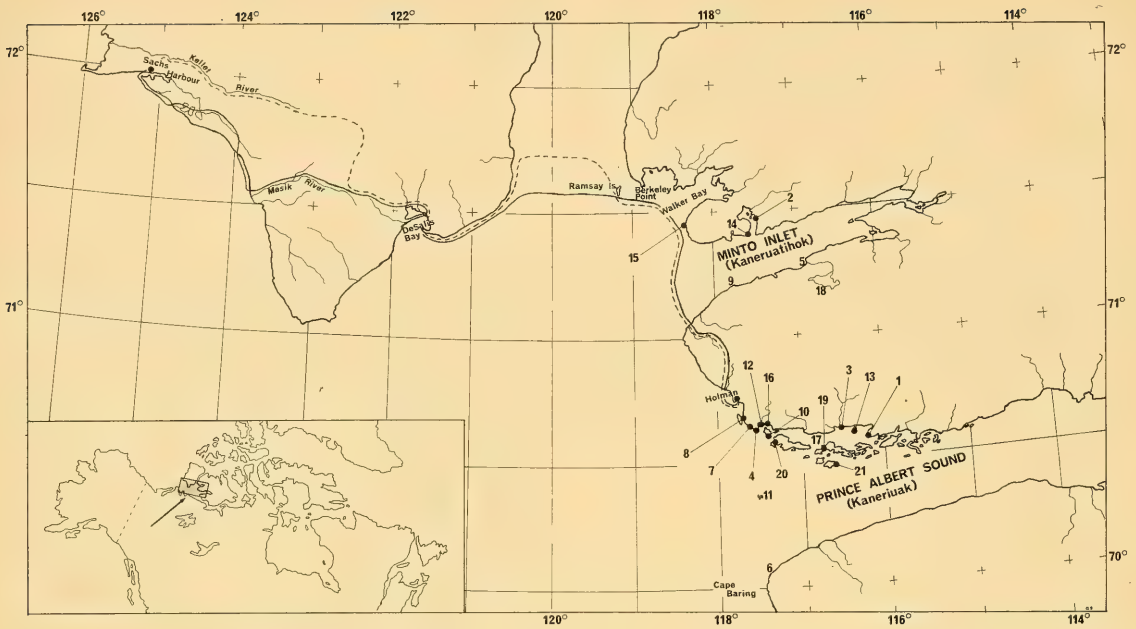

FIGURE 1. A map of the study area with the routes travelled to (solid line) and from (dashed line) Sachs Harbour on western Banks Island. The following list gives the place names corresponding to the numbers on the map: 1. Hinigyoak, 2. Ongirot, 3. Kayalihok, 4. Koaroakat, 5. Kurdjuak, 6. Kurgayuak, 7. Malinik, 8. Masoyak, 9. Nauyan, 10. Nauyat, 11. Nunungiak, 12. Okak, 13. Omanak, 14. Omingmugiuk, 15. Pinoyoak, 16. Pitotak, 17. Tahiyauk, 18. Tatik, 19. Torhokatak, 20. Torhok, 21. Illuvilik.

missed and for the same reason observation of courting behaviour and nesting is scant. Because I was away from 8 August to 15 September, I missed the departure of many species from the area.

Species marked with an asterisk are birds thought to be present in the area but which have been only tentatively identified by me, or which are based on unconfirmed indentification by the Eskimos. Most of these species have been reported previously for Banks and Victoria Island and occur in inland marshy habitats which were missed in this study.

A special effort was made to obtain the Holman Eskimo names for each species. It was found that in many cases these differed from the names given in Snyder (1957), especially when dealing with the more eastern distributed species. The resemblance to names for species common in the Mackenzie Delta region and the Perry River area was much greater, but rarely were they identical. Usually birds rare to the area had no local name. Information about behaviour and nesting was also sought from the native Eskimos and the few species which were seen by them, but not by me, are noted and included.

In most cases the taxonomic authority followed is the fifth edition of the American Ornithologists' Union Check List of North American Birds (1957). Exceptions to this involved the following species: Brant, Snow Goose, and Thayer's Gull. The authority followed in these cases is Godfrey (1966).

Annotated List

YELLOW-BILLED LOON. *Gavia adamsii* (Gray). Toodlik. — The least common of the three species of loons along the coast near Holman. First seen on 6 June along the ice edge near Nunungiak (Figure 1). None were seen on the small lakes near the coast. Occasionally seen flying along the coast from June to August and last seen in mid September. No immatures were observed.

This species is occasionally shot by the local hunters for food and the skin used for decorative wearing apparel. Very little mortality occurs in this way how-

ever since the people do not travel inland to any great extent during the summer months. Nesting is reported by the natives on the larger inland lakes.

ARCTIC LOON. *Gavia arctica* (Linnaeus). Malerok or Kaglulik. — The second most common species of loon along the coast near Holman. First seen during the first week of June on a small meltwater pond approximately 150 meters from the shore. A pair was observed on a small lake near Kurdjuak, in Minto Inlet, on 12 July. Flocks of up to 12 individuals were seen flying together along the coast in a southeasterly direction as late as 22 September.

RED-THROATED LOON. *Gavia stellata* (Pontoppidan). Ivitalik or Kaksaut. — Most frequently observed species of loon along the coast, from Minto Inlet to Prince Albert Sound. First sightings occurred in late June. A pair was seen on a small lake near the Kurdjuak River mouth, in Minto Inlet, on 12 July. At this time an empty nest was found approximately 2 feet from the lake edge. This nest contained one egg on 13 July, and two eggs the next day. One adult male was collected.

WHISTLING SWAN. *Olor columbianus* (Ord). Kogiuk. — First observed on 19 May in the Masik River valley on Banks Island. The species is not abundant along the coastal region near Holman, but adults were seen occasionally from June to August. On 12 July, a pair was observed at the edge of Tatik Lake, a large body of water approximately five miles inland, south of Minto Inlet (Figure 1). No young were seen during my stay but the Eskimos report that successful nesting does occur in the area, and pointed out small ponds on a point called Okak (Figure 1), which apparently has been a traditional nesting site.

CANADA GOOSE. *Branta canadensis* (Linnaeus). Olaudlik. — Very uncommon along the west coast of Victoria Island. Two flocks, one of 5-10 birds and the other of 4 birds, were seen in the first week of June and around mid July respectively. The Eskimos report seeing nests occasionally around inland lakes. One Eskimo recalls finding a fair number of nests near the coast along the Kurgayak River.

BRANT. *Branta bernicla* (Linnaeus). Nedlernak. — A fairly common bird in the study area. The first sighting was on 10 June at Malinik (Figure 1). Occasional flocks were seen during early June. No nests or nesting activity was seen but Brant are reported to be fairly common on small lakes inland, where they nest successfully. The Eskimos occasionally hunt the flightless young on small ponds in August.

The Brant I observed were dark breasted and probably referable to the race *B. nigricans* (Figure 2). This agrees with the observation of Parmelee et al. (1967) for southeastern Victoria Island, Porsild (1951), and Manning et al. (1956) for Banks Island.

WHITE-FRONTED GOOSE. *Anser albifrons* (Scopoli). Nedlervik. — Very rare. Positively identified by J. Memogana from the Holman area. Smith and Sutton (1953) and Parmelee et al (1967) report small pockets of these birds in the Cambridge Bay region of southeast Victoria Island and consider the race to be *Anser albifrons frontalis.*

FIGURE 2. A dark-breasted Brant, *Branta bernicla nigricans,* shot at Malinik in early June.

SNOW GOOSE. *Chen caerulescens* (Linnaeus). Kangok. —Flocks were occasionally seen in the Holman area during late May and June. First sightings were made on the south coast of Banks Island south of Sachs Harbour on 20 May. The geese had, according to the Sachs Harbour natives,, begun flying in around 10 May. During a 2 hour observation period along the coast on 20 May flocks of from 50 to 200 birds were seen flying inland at frequent intervals. All geese seemed to be coming from the direction of Cape Parry. No breeding activity was observed on Victoria Island, but reports of a Snow Goose nesting area near the Kurgayuak River on Prince Albert Sound, were received from several natives of Holman.
Parmelee et al. (1967) considers the Snow Goose an uncommon transient on southeastern Victoria Island, which also appears to be the case in the present study area. No blue phase birds were seen either on Victoria or Banks Island by me, although they have been observed by other workers in both places (Parmelee et al. 1967; Manning et al. 1956).

MALLARD. *Anas platyrhynchos* Linnaeus. Kerkak. — — A rare visitor to the Holman area. Twice sighted; once a drake flying alone on 22 June, and once with some Common Eiders, during the last week of June along the ice edge near Holman. No specimens were shot at Holman in 1971 but the Eskimos reported shooting some in other years. Mallards have also been seen on small ponds in the Minto Inlet area during the warm months.

The Holman Eskimo name Kerkak used for this species corresponds to the name used in the Perry River region for the Pintail (Snyder, 1957). This species has not been reported previously on either Victoria or Banks Islands.

[*PINTAIL *Anas acuta* Linnaeus. — This species was not observed by the author, but one adult male was

shot in mid June by an Eskimo at Holman. This is not the first time this species has been seen there, but it is very rare and there is no local Eskimo name for it. Parmelee et al. (1967) report it as an uncommon but regular visitor to southeastern Victoria Island.]

[*SHOVELER. *Spatula clypeata* (Linnaeus). — One Eskimo at Holman reported shooting a male of this species at the village of Holman during the first week of June 1971. This was the first time that this species had been seen there. I was not able to verify the identification, since the specimen had been lost. No local Eskimos name exists for this species. This is apparently the first report of this species above the arctic mainland where it has been previously reported from the Mackenzie Delta (Porsild, 1943) and the northern Yukon (Godfrey, 1966).]

OLDSQUAW. *Clangula hyemalis* (Linnaeus). Ahunga. — The second most common duck in the Holman region, first sighted 3 June along the floe edge. Copulation was observed in the water along the ice edge during the first three weeks of June. No nests were found but the Eskimos reported nesting around small ponds and on islands. Moulting Oldsquaws were observed occasionally on the sea in late July and early August. Sightings of Oldsquaw became rare along the coast after mid July, and were completely absent from the area by mid September.

These birds are shot occasionally for food, but no large hunting mortality exists since the eiders are the much preferred food species.

COMMON EIDER. *Somateria mollissima* (Linnaeus). Amaulik (male), Horluktuk (female). — This was the third most common species of duck. First seen 28 May but movement into the area was reported to start about 10 days previously. The Common Eider is much less abundant than the King Eider in this area and hunt bag returns indicate that they represent 5.0 percent of the total eider population.

Nesting was observed on small rocky islands near Holman and up to seven eggs per nest were counted. Nesting appears to be later than for the King Eiders and mated pairs were seen as late as the beginning of August. Eggs were seen during the first week of July but laying could have started two weeks previous to this.

Moulting adults were seen on 25 July and males were rarely seen in August. No Common Eiders were seen after my return to the study area in mid September.

KING EIDER. *Somateria spectabilis* (Linnaeus). Kingalik (male), Mitterk (female). — This is the most abundant of the anseriform species on western Victoria Island. First sightings were made 28 May although several reports indicate first arrivals began one week previous to this.

Both King and Common Eiders arrive in the Holman area flying south along the Victoria Island coast. The Eskimos believe that these flights cross from the mainland somewhere near Cape Parry to Banks Island. From there they either cross Banks Island or follow the east coast up to the Prince of Wales Strait where they cut across the narrows east to Victoria Island, then south along the coast. These observations come from Eskimos who have lived on Banks Island, in the Minto Inlet area of Victoria Island, and finally at Holman; thus they are well situated to observe this flight path.

During the month of June a duck hunting camp is set up at Masoyak (Figure 1), and birds are hunted as they fly low over the sea ice between Holman Island and the camp on the mainland. The main hunting activity at the Masoyak camp occurs during the first two weeks of June. During this period, there were nine families camped there. In this group there were eleven Eskimo men hunting ducks. A very rough estimate of the total take for a two week period is derived from two days of hunting, which I observed. The mean yield per hour/per man, for two 8 hour hunting days was 5.25 ducks. In a period of two weeks with eleven men hunting an average of eight hours a day this results in a catch of 6,468 eiders. This is an underestimate of total mortality around Holman since it does not include the probably high crippling mortality, the take of the children hunters which is considerable, or the catch of 14 other families either living in Holman or other seal hunting camps.

King Eiders appear to nest earlier than Common Eiders. Nests with up to seven eggs were observed on a small island, Nunungiak, on 30 June. Incubation had begun, and partially developed embryos were seen in some of the eggs eaten by the Eskimos.

During the first weeks of July, there is a movement of drakes north along the Victoria Island coast. This apparently is part of the movement south to the Bering Sea wintering grounds. After this, King Eiders become increasingly rare except for females and young. Moulting females were seen on 7 July and flightless young collected as late as 15 September. According to the Eskimos, the young of the Common Eider stay later than those of the King Eider which leave around the beginning of September.

[*WHITE-WINGED SCOTER. *Melanitta deglandi* (Bonaparte). Tunravik. — Tentatively identified twice in flight travelling with King Eiders in early June. Reported to have been shot occasionally by several local hunters who positively identified this species from pictures. No specimens were seen during my stay.

This species has not previously been reported on Victoria Island. It is common along the Alaskan coast and in the Mackenzie Delta (American Ornithologists' Union checklist, 1957).]

RED-BREASTED MERGANSER. *Mergus serrator* Linnaeus. — There is no local Eskimo name for this duck which is known by the mainland Eskimos as Nooyalik (Snyder, 1957). One adult male specimen was shot near the village of Holman by Donald Nootaina, on 7 June. No other sightings were made during my stay. Parmelee et al. (1967) list this species as a rare breeder on southeastern Victoria Island, but no local reports on previous sightings or breeding activity exist for the present study area.

ROUGH-LEGGED HAWK. *Buteo lagopus* (Pontoppidan). Kalak. — The most common hawk in the area. First seen along the ridges and cliffs behind the village of Holman on 30 May. These hawks are common along the whole of the coastline where there are high cliffs for nesting sites.

The first nest seen was at Nauyat in Minto Inlet on 9 July. It was not possible to see if there were eggs present, but the protective behaviour of the pair at this site indicated that laying had probably begun. Another nest containing four downy young was seen at Kayalihook on the face of a 100 foot cliff on 21 July. There were two other nests of the same willow construction near the first one. One was empty but the other contained a female Common Eider. The duck did not move as we approached from the other side of the ravine and appeared to be incubating; she did not seem to recognize the hawk as a potential predator on her young. A few hawks were seen as late as mid September.

PEREGRINE FALCON. *Falco peregrinus* Tunstall. Kiligavik. — Uncommon in the study area. In 1971 four different sightings were made during the month of July all in the Tahiyuak area of Prince Albert Sound. No nests were seen but the Eskimos said that this species nests in the area. In 1972 one Peregrine Falcon was seen attacking a Rock Ptarmigan near Iluvilik on 6 June. Two pairs were seen flying around the high bluffs at Hinigyoak on 10 June. The birds appeared upset by our presence and it was assumed that there was a nest close by.

Porsild (1951) noted nests in Minto Inlet, on Holman Island, and Washburn Lake. He states that this species was common in the area but this is not borne out by the present investigation.

[*SPARROW HAWK. *Falco sparverius* Linnaeus. — Although this species was not seen during my stay at Holman several local residents report the occasional sighting of a small hawk resembling this species. Parmelee et al. (1967) report seeing it on Jenny Lind Island off southeastern Victoria Island. It has not been reported previously from the Canadian archipelago.]

WILLOW PTARMIGAN. *Lagopus lagopus* (Linnaeus). Arhkiligivik. — Very uncommon in the present study area. One specimen was shot at Ramsay Island on 26 May. No others were seen on Victoria Island, but the Eskimos report that there are pockets of Willow Ptarmigans near large willow stands, and especially in the area north of Walker Bay, on northwestern Victoria Island.

ROCK PTARMIGAN. *Lagopus mutus* (Montin). Nikaktok. — Occasionally seen in March, April and May, but less frequently in the summer months because of decreased overland travel. No nests were seen but the Eskimos report that nesting is common on the rocky ridges in the area. On 25 June three individuals were seen in full summer plumage.

Porsild (1951) found this species to be almost entirely absent from both Banks and Victoria Islands. This may have been due to a cyclic variation in their density.

SANDHILL CRANE. *Grus canadensis* (Linnaeus). Tatiligak. — Cranes were first sighted flying west over Mount Phayre (Pinoriyuak), north of Minto Inlet, on 17 May and on a number of occasions in late May and June in the Holman area. Eskimos had been reporting sightings from the areas around the Holman village from approximately 10 May. On 29 May, Tom Pigalak, a Holman Eskimo, reported seeing a nest which contained two eggs, situated three miles inland from Holman.

Parmelee et al. (1967) report Sandhill Cranes as uncommon in southeastern Victoria Island. Cranes appear to be more abundant in the present area, probably because of the closer proximity to the large population of southern Banks Island (Manning et al. 1956).

SEMIPALMATED PLOVER. *Charadrius semipalmatus* Bonaparte. Kudlakudlak. — Common, nesting on big rocky ridges inland and near the coast. Nests containing up to four eggs were seen on 2 July and on several more occasions during the first two weeks of July. Sightings became infrequent in August and none were seen during September.

Parmelee et al. (1967) classify these as highly local summer residents in southeastern Victoria Island. They appeared to be much more common in the present region.

AMERICAN GOLDEN PLOVER. *Pluvialis dominica* (Müller). Tudligark. — None were seen by me in 1971 but were reported as rare breeders in the area by several Eskimos. On 11 June 1972 a pair were positively identified at Iluvilik.

Höhn (1955) reports these from the Holman area and Parmelee et al. (1967) list them as common breeders on southeastern Victoria Island.

[*BLACK-BELLIED PLOVER. *Squatarola squatarola* (Linnaeus). — Not seen during my stay and only tentatively identified from pictures (possible confusion with *Pluvialis dominica* which is definitely present) by the natives. Reported by Porsild (1951) and Manning et al. (1956) as common in marshy areas on Banks Island and as an abundant breeder in low lying wet tundra, in the Cambridge Bay area by Parmelee et al. (1967).]

[*RUDDY TURNSTONE. *Arenaria interpres* (Linnaeus). Taligvark. — Not sighted during my stay in the area but positively identified as a rare breeder by several local residents. Parmelee et al. (1967) list *Arenaria interpres morinella* as a commond breeder on southeastern Victoria Island. Manning et al. (1956) found it fairly abundant on western Banks Island but surprisingly scarce in the De Salis Bay region.]

[*WHIMBREL. *Numenius phaeopus* (Linnaeus). — Positively identified by two long term resident Eskimo hunters as very rare visitors to the Holman area. Both Manning et al. (1956) on Banks Island and Parmelee et al. (1967) near Cambrdige Bay list this species as very rare or accidental in their study areas.]

WHITE-RUMPED SANDPIPER. *Erolia fuscicollis* (Vieillot). Hygiariak. — A large number of these were seen around the melt-water ponds near our camp at Iluvilik. First seen on 6 June 1972. The male of the species appeared to be establishing territories and frequent displays were observed. These could have been territorial or epigamic. Typically, a male would fly approximately 40 feet off the ground with a hovering or slow forward flight while making a drawnout

chirping or whirring sound. Since a number of birds made this sound when we approached their habitual perching places, I assume that this display was in a large part territorial. No nests were found before our departure from Iluvilik on 16 June.

BAIRD'S SANDPIPER. *Erolia bairdii* (Coues). Higyariak. — The most common of the shorebirds in the area. First sighted 29 May in the grassy low lying areas around the Holman village. Nests were seen from the last week of June until the first week of July containing two to four eggs. Nests were situated in low vegetation often along erosion ditches. Flock movements were noticed in early August and no sandpipers were seen upon my return in mid-September.

The Eskimo name Higyariak is used for all the species of small sandpipers seen in this area.

BUFF-BREASTED SANDPIPER. *Tryngites subruficollis* (Vieillot). Higyariak. — Thinly distributed in the area, restricted to well drained grassy areas around the village of Holman, and first sighted during the second week of June. Territorial displays were noticed from mid to late June.

NORTHERN PHALAROPE. *Lobipes lobatus* (Linnaeus). Havrak. — This species was first sighted 12 June along the ice edge where later in June many small groups of these birds were seen feeding. None were seen once the ice had broken up. It is not known by the Eskimos if this species breeds in the area, although Parmelee et al. (1967) report it as a rare breeder on southeastern Victoria Island.

POMARINE JAEGER. *Stercorarius pomarinus* (Temminck). Ihungahoak. — Common in the area and highted occasionally during late May, June and July flying along the ice edge and over open water. The first seen (on 20 June) was an adult male feeding on small fish which were abundant near the ice edge. Breeding is reported to occur in the area but no nests were seen.

PARASITIC JAEGER. *Stercorarius parasiticus* (Linnaeus). Ihunga. — Rarest jaeger in the area. First seen on 29 June. Eskimos report that this bird is often seen inland where nesting is common. No nests were found and sightings were made infrequently over open water only during July.

LONG-TAILED JAEGER. *Stercorarius longicaudus* Vieillot. Ihunga. — This appeared to be the most common of the three species of jaegers in the area. They were seen frequently during July along the coast of Prince Albert Sound. On 22 July one female attacked me repeatedly as I evidently walked near her nest.

GLAUCOUS GULL. *Larus hyperboreus* Gunnerus. Nauyavik The most common gull in the area. It was frequently seen everywhere on the coast from Prince Albert Sound to Minto Inlet. First seen in late May. Nests were seen both on small islands and at a few cliff colonies in Minto Inlet and along the coast southeast of Holman. One island visited on 14 July in Minto Inlet had approximately 15 nests on it. There was no sign of eggs or young and it was suggested by my Eskimo assistant, that perhaps the nests had been predated by foxes, although no evidence of this was seen.

THAYER'S GULL. *Larus thayeri* Brooks. Nauyahoak. — Much less common than the Glaucous Gull but frequently sighted all along the coast between Minto Inlet and Prince Albert Sound. First observed in late May. Young of the year were sighted flying around islands in Prince Albert Sound in the company of adult Thayer's Gulls as well as Glaucous Gulls until 1 October.

Breeding colonies of this species are known on the Findlayson and Richardson Islands off southeastern Victoria Island (Parmelee et al. 1967). Some colonies are also known on the southwest coast of Banks Island and one on the northern extremity of the island near Cape McClure (Manning et al. 1956).

SABINE'S GULL. *Xema sabini* (Sabine). Irkilagogiak. — Frequently seen along the ice edge during June and early July. First seen during the second week of June. Sightings became infrequent as the ice broke up and none were seen after the first week of July. The natives did not know of this species nesting in the area. Parmelee et al. (1967) report abundant breeding on southeastern Victoria Island. Porsild (1951) apparently did not see this species in this area, and Manning et al. (1956) classify it as rare on nearby eastern Banks Island, though present on the west coast as a rare breeder.

ARCTIC TERN. *Sterna paradisaea* Pontoppidan. Imitkotailak. — Seen only during mid June to early July along the ice edge where they were feeding on small fish. No nests or individuals were seen on any inland walks or along the coast after early July. The Eskimos report that this species is sometimes seen nesting around small inland lakes.

THICK-BILLED MURRE. *Uria lomvia* (Linnaeus). — Very rare, and consequently no local Eskimo name for this species. First sighted on 18 june among floating pack ice, about one half mile from shore near Malinik. Four more sightings were made through June and early July. One adult male, collected 5 July, had the following measurements: exposed culmen, 37.0 mm; wing, 213.0 mm; body length, 195.0 mm; total length, 435.0 mm. These are slightly larger than those given by Parmelee et al. (1967) for a single specimen taken at Cambridge Bay.

DOVEKIE. *Plautus alle* (Linnaeus). Atpa or Igiuk. — Although rare, individuals of the species are infrequently seen by the natives, almost every year. One specimen shot 26 June was shown to me by a Holman Eskimo. The name Atpa is similar to the name used by more eastern Eskimos, e.g. from Southampton Island, for the Thick-billed Murre. The name Igiuk, meaning testicle, is more local and is known to most of the Holman residents.

Neither Porsild (1951) nor Parmelee et al. (1967) saw this species on Victoria Island. Manning et al. (1956) did not observe any but they report possible sightings by the natives on western Banks Island. Specimens have been collected as far west as Point Barrow on the mainland (Bailey, 1948) and one as far north as Melville Island (Swainson and Richardson 1813, p. 479.).

BLACK GUILLEMOT. *Cepphus grylle* (Linnaeus). — Another very rare alcid in this area. No local name was known for this species and very few of the Holman natives had seen it previously. Two sightings of this species were made, one on 8 July and the other approximately one week later.

SNOWY OWL. *Nyctea scandiaca* (Linnaeus). Ookpik. — A common species through the year in this area. Snowy Owls were occasionally sighted from March through June flying along the coast and often over the land fast ice. No nests were seen during my stay, but the Eskimos report that nesting is common in this area, especially during the years of high lemming density.

Snowy Owls are shot, whenever available, for food. The largest mortality is inflicted on this species in the fall when large numbers of these birds move past the village of Holman. At the beginning of October the natives begin hunting owls on the flat coastal area west of the Holman village. On 10 October during a two hour walk in this area I counted seven owls. Hunt returns and my own observations indicated that there was a high proportion of immature Snowy Owls in the area at this time. The Eskimos believe that these birds, which apparently appear at this time in most years, are from areas in the north, and are on a southward migration. They also report that the numbers of owls are cyclic and appear to be correlated with lemming abundance, a fact well documented by other studies.

No estimates of the total take of owls during the first two weeks of October are available, but it must be quite high. Owls are hunted by all members of the community. Several hunting methods are used and these include: shooting with scope mounted rifles; trapping with No. 1.5 or 2.0 steel traps set on platforms; and the occasional use of set-guns. One hunter who went hunting by snowmobile for approximately three hours on 10 October returned with 13 owls. Owls apparently become scarce in late October and very few are taken during the winter or summer months, although some are always present in the area.

HORNED LARK. *Eremophila alpestris* (Linnaeus). Kopanoarpariuk. — Very common in the area. First seen 29 May near the Holman village. Nests were observed on dry rocky areas near the coast at Malinik, but were also observed farther inland. None were seen after mid-September.

BARN SWALLOW. *Hirundo rustica* Linnaeus. — No local name for this species. One specimen was brought to Mr. Brian Gladfield, the school principal, in early June, by one of the native children. Several Eskimos reported seeing this kind of bird one or more times in the area. Sweatman (1951) collected a specimen of *Hirundo rustica erythrogaster* near Cambridge Bay. This is the only other positive record from Victoria Island.

COMMON RAVEN. *Corvus corax* Linnaeus. Tulugak. — Common in the area but infrequently seen from May through October. Several Eskimos report that a number of ravens used to nest regularly on the cliffs of Holman Island until about five years ago. At this time they apparently were killed off by poison bait used in a wolf control effort and have not nested in the area again. No other nesting areas were known in the Holman vicinity and no nests were found during my stay there. Two groups of ravens were sighted in late September; one group contained four and the other group five individuals of which several were yearling birds. The natives report that sightings of ravens are made infrequently in mid-winter near the village of Holman.

WATER PIPIT. *Anthus spinoletta* (Linnaeus). — Not seen by me or reported by the natives but listed for the area by Höhn (1955).

[*RUSTY BLACKBIRD. *Euphagus carolinus* (Müller). — This species is only tentatively listed because of the possibility of confusion with Brewer's Blackbird. A number of local residents report seeing small blackbirds around the village of Holman in most years. None were seen by me but several different Eskimos identified the bird from pictures in the field guides.

This species has not previously been reported from the arctic archipelago. The northernmost previous report appears to be from Point Barrow, Alaska (American Ornithologists' Union, checklist, 1957).]

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys* (Forster). — No local name. Seen once in tall willows near Ongirot, in Minto Inlet, on 14 July 1971. In 1972 one male specimen was collected at Iluvilik. At least three others were seen in the same area the following day. The sightings occured after four days of strong east winds. This species has not been reported previously from Victoria Island, but a specimen identified as *Zonotrichia leucophrys gambelii* was collected near the Sachs Harbour settlement on Banks Island in 1953 (Manning et al., 1956). One specimen was also collected off southeastern Victoria Island, on Jenny Lind Island, in 1966 (Parmelee et al., 1967), and also referred to the subspecies *gambelii*.

LAPLAND LONGSPUR. *Calcarius lapponicus* (Linnaeus). Nasauligak. — One of the most common nesting birds in the area. Nests were observed in mid-June in hummocks and vegetation in both low lying wet areas and on well drained rocky ridges near Malinik. No eggs were seen in June although the behaviour of some of the birds indicated that laying had begun. On 2 July two nests were found in the same area, one containing five, and the other six eggs. No young were observed and this species was absent from the area after my return on 19 September.

SNOW BUNTING. *Plectrophenax nivalis* (Linnaeus). Amauligak. — Vervy common, but must less abundant than Lapland Longspurs in the area. Most common in the area immediately around the village of Holman consisting of rocky slopes and nearby well drained grassy areas. It appears to be thinly distributed through the present area and is abundant in a few localities only, usually near the coast in rocky situations next to old beach levels. One of the earliest arrivals in the area, first seen on 3 May.

Territorial males were observed on a rocky ridge behind the village of Holman. On 29 June, one nest was seen there which contained five unhatched eggs.

Flying immatures were sighted first in mid-July and territorial behaviour appeared to have mostly ceased by that time. No sightings were made of this species after my return in mid-September.

* Hypothetical

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Literature Cited

American Ornithologists' Union. 1957. Checklist of North American birds (Fifth edition). 691 p.

Bailey, A. M. 1948. Birds of Arctic Alaska. Colorado Museum of Natural History Population Service 8: 1-317.

Ellis, D. V. 1956. Observations on the migration, distribution and breeding of birds in the Canadian Arctic during 1954 and 1955. Dansk Ornithologisk Forenings Tidsskrift 50: 207-230.

Fraser, J. Keith. 1957. Birds observed in the central Canadian Arctic, 1953, 1955, 1956. Canadian Field-Naturalist 71: 192-199.

Geale, John. 1971. Birds of Resolute, Cornwallis Island, Northwest Territories. Canadian Field Naturalist 85: 53-59.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203: 1-428.

Höhn, E. O. 1955. Birds and mammals observed on a cruise in the Amundsen Gulf, N.W.T., July 29th-August 16th, 1953. Canadian Field-Naturalist 69: 41-44.

MacDonald, S. D. 1954. Report on biological investigations at Mould Bay, Prince Patrick Island, Northwest Territories in 1952. National Museum of Canada Bulletin 132: 214-238.

Macpherson, A. H. and **T. H. Manning.** 1959. The birds and mammals of Adelaide Peninsula, Northwest Territories. National Museum of Canada Bulletin 161: 1-63.

Manning, T. H., E. O. Höhn and **A. H. Macpherson.** 1956. The birds of Banks Island. National Museum of Canada Bulletin 143: 1-144.

Parmelee, D. F., H. A. Stephens and **R. H. Schmidt.** 1967. The birds of southeastern Victoria Island and adjacent small islands. National Museum of Canada Bulletin 222: 1-229.

Porsild, A. E. 1943. Birds of the Mackenzie Delta. Canadian Field-Naturalist 57: 19-35.

Porsild, A. E. 1951. Bird notes from Banks and Victoria Island. Canadian Field-Naturalist 65: 40-42.

Smith, R. H. and **E. L. Sutton.** 1953. Waterfowl breeding ground survey in northern Alberta, the Northwest Territories and the Yukon. U.S. Fish and Wildlife Service, Special Scientific Report 25: 7-15.

Snyder, L. L. 1957. Arctic birds of Canada. University of Toronto Press. 310 p.

Storer, R. W. 1952. A comparison of variation, behaviour and evolution in the sea bird genera *Uria* and *Cepphus*. University of California Publications in Zoology 52: 121-222.

Swainson, W. and **J. Richardson.** 1831. Fauna Boreali-Americana. The Birds. Vol. 2 London. 523 p. + plates.

Sweatman, G. K. 1951. The Barn Swallow at Cambridge Bay, Northwest Territories. Canadian Field-Naturalist 65: 184.

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The Nesting of the Great Cormorant (*Phalacrocorax carbo*) and the Double-crested Cormorant (*Phalacrocorax auritus*) in Nova Scotia in 1971

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Abstract. Thirty colonies, containing some 4150 pairs, of the Double-crested Cormorant (*Phalacrocorax auritus*) were censused. Only ten of these had been censused previously and increases in size were noted in five. Twenty-three colonies, containing some 2050 pairs, of the Great Cormorant (*Phalacrocorax carbo*) were censused. Of the seven which had been previously censused, three had increased in size. Great Cormorants were found breeding on four islands south of their previously known breeding range and the populations of both species appear to be increasing. The Great Cormorants nest on cliffs or on the ground on rocky islets while the Double-crested Cormorants always nest on islands, usually in spruce trees.

Introduction

Cormorants are common on the coast of Atlantic Canada; as they feed in shallow waters close to shore and in estuaries, they are easily seen. They breed in compact colonies and while these can often be easily and accurately censused, knowledge of their numbers and distribution is often fragmentary as these colonies are usually in sparsley populated and inaccessible areas. Both Great Cormorants (*Phalacrocorax carbo*) and Double-crested Cormorants (*Phalacrocorax auritus*) breed in eastern Canada from southern Nova Scotia to the North Shore of the Gulf of St. Lawrence and Newfoundland.

In Nova Scotia, cormorants have attracted the attentions of several workers who have censused various colonies and provided some historical background for each species. H. F. Lewis (1929) prepared a monograph on *P. auritus* and made a wide ranging search for new colonies, producing many short distributional papers including an estimate of the size of the North American population of *P. carbo* (Lewis 1941). Peters (in Erskine 1972) made many observations on the colony at Crystal Cliffs near Antigonish while Bailey (1925), Tufts (1962) and others visited several colonies and their reports and notes provide a fairly continuous record of the large colonies on Hertford and Ciboux Islands since 1925. Recently Erskine (1972) has reviewed the literature concerning the occurrence of *P. carbo* in eastern Canada. But no one attempted a search of the entire coast of this province, consequently attempts to detect population changes and trace shifts in the breeding ranges of the two species are difficult.

The task of documenting breeding colonies is further complicated by the difficulties which some observers have had in differentiating between the two species. At the time that most colony visits are made, in June and July, the two cormorants are not easy to tell apart except at close range. From January to May *P. carbo* displays prominent white flank patches, but these disappear in June and one must rely on differences in the colour of the gular pouches and, where both species are present, on size differences.

Methods

In an effort to elucidate the status of these species in Nova Scotia, a search of the entire coastine of the province was made. A light plane was used for the search and all colonies found were examined from a low level. Counts were made of nests in cliff colonies and black and white photographs were taken of some ground nesting colonies using a 35 mm camera with a 135 mm lens. Individual nests were visible on 5" × 7" enlargements. It was not

TABLE 1. — Numbers of breeding pairs and locations of Great and Double-crested Cormorant colonies in Nova Scotia in 1971.

Colony Location	Latitude	Longitude	Number of Nests		Count Method
			Great Cormorants	Double-crested Cormorants	
Blue Gull Rock, Shelburne Co.	43°40′N	65°13′W	20–30	400–430	GC
Green Island, Shelburne Co.	43°45′N	64°56′W	30–35	240–250	APE
Indian Island, Lunenburg Co.	44°10′N	64°24′W	–	172+	APE
Little Duck Island, Lunenburg Co.	44°22′N	64°11′W	–	150–190	GC
Southwest Island, Halifax Co.	44°30′N	64°00′W	–	170–180	GC
Barren Island, Halifax Co.	44°42′N	62°58′W	–	140–150	GC
Bald Island, Halifax Co.	44°42′N	62°48′W	–	170–180	GC
Horse Island, Halifax Co.	44°51′N	62°32′W	–	33	GC
Islet off Guildford Island, Halifax Co.	44°48′N	62°32′W	17	–	GC
Speck Island, Halifax Co.	44°51′N	62°24′W	–	8	GC
Horse Island, Halifax Co.	44°50′N	62°22′W	–	213	GC
West Brother Island, Halifax Co.	44°49′N	62°22′W	227	–	GC
Long Island, Halifax Co.	44°54′N	62°18′W	–	68	GC
Middle Halibut Island, Halifax Co.	44°54′N	62°12′W	–	200–250	GC
Little White Island, Halifax Co.	44°54′N	62°06′W	–	121 adults	GC
Tobacco Island, Guysborough Co.	45°01′N	61°55′W	–	180–200	GC
Goose Island, Guysborough Co.	45°07′N	61°34′W	–	185	GC
Islet N.E. of Coddle Island, Guysborough Co.	45°09′N	61°31′W	–	10	GC
West Sugar Island, Guysborough Co.	45°13′N	61°17′W	–	470–500 adults	GC
Island S.W. of Port Felix, Guysborough Co.	45°14′N	61°14′W	–	10	GC
Millstone Island, Guysborough Co.	45°12′N	61°07′W	–	23	GC
Crow Island, Guysborough Co.	45°21′N	60°57′W	–	172	GC
Campbell Island, Richmond Co.	45°33′N	61°09′W	–	305	GC
Red Island, Richmond Co.	45°48′N	60°46′W	–	315	GC
Eastern Basque Island, Richmond Co.	43°35′N	60°39′W	95–100	20–25	GC
Rock N.E. of Fourchu Head, Richmond Co.	45°43′N	60°13′W	30–50	65–85	GC
Sugarloaf Island, Cape Breton Co.	45°48′N	60°05′W	160–180	15–20	GC
Green Island, Cape Breton Co.	45°49′N	60°04′W	27	–	GC
Kennington Rocks, Cape Breton Co.	45°52′N	60°04′W	84	–	GC
Portnova Island, Cape Breton Co.	45°56′N	59°48′W	507 adults	–	GC
Hay Island, Cape Breton Co.	46°02′N	59°42′W	94	–	GC
Cape Morien, Cape Breton Co.	46°08′N	59°48′W	65–75	–	AVE
Cape Perce, Cape Breton Co.	46°10′N	59°49′W	94	–	GC
Double Island*, Victoria Co.	46°04′N	60°44′W	–	225	GC
Hertford Island, Victoria Co.	46°22′N	60°24′W	310	–	GC
Ciboux Island, Victoria Co.	46°23′N	60°23′W	88	–	GC
Ingonish Island, Victoria Co.	46°41′N	60°20′W	99	–	GC
Money Point, Victoria Co.	47°02′N	60°23′W	12–20 adults	–	AVE
Cheticamp Island, Inverness Co.	46°36′N	61°04′W	45–55	–	AVE
Margaree Island, Inverness Co.	46°22′N	61°16′W	75–85	–	AVE
Coalmine Point, Inverness Co.	46°07′N	61°29′W	80+	–	GC
Cape George, Antigonish Co.	45°53′N	61°54′W	12	–	AVE
Lakevale, Antigonish Co.	45°47′N	61°54′W	2	–	GC[1]
Crystal Cliffs, Antigonish Co.	45°43′N	61°54′W	33	–	AVE
Pictou Wharf, Pictou Co.	45°38′N	62°43′W	–	88	GC[2]
Egg Island, Cumberland Co.	45°23′N	64°08′W	–	79	APE
Boot Island, King's Co.	45°08′N	64°16′W	–	40–45	GC
Cape Split, King's Co.	45°20′N	64°30′W	–	26	GC

*Known also as Spectacle Island or Toothbrush Island.
[1]Censused by A. MacDonald (personal communication).
[2]Censused by E. Lowerison on June 5, 1971 (Lowerison, 1972)

possible to make exact population estimates of tree-nesting colonies from the air though colour transparencies allowed some good counts to be made. As many as possible of the colonies were later visited by boat to obtain accurate counts and species identifications. Colony visits were made between May 18 and June 27. Aerial censuses were done on May 28 in Minas Basin and the Bay of Fundy; on May 29 along the north and northeast coasts of mainland Nova Scotia and into Bras D'or Lake; and one June 11 around the southern part of the province.

Results and Discussion

Breeding Population Size

The results of the census are presented in Figure 1 and in Table 1. Abbreviations used are APE meaning aerial photographic estimate; AVE meaning aerial visual estimate; and GC meaning ground count. MNR indicates that information has been taken from a card on the Maritimes Nest Record Scheme. In Table 2 we present some previous censuses of these colonies and in Table 3 we list records for some colonies which have recently disappeared.

Thirty colonies of *P. auritus* were censused, giving a total of approximately 4150 pairs breeding in Nova Scotia. Ten of these colonies had been censused previously and large increases are apparent in five of them: Indian I., Boot I., Tobacco I., Double I., and Pictou Wharf. There are also indications of a large increase in the Bald I. colony. Only one colony, Cape Split, seems to have decreased in size re-

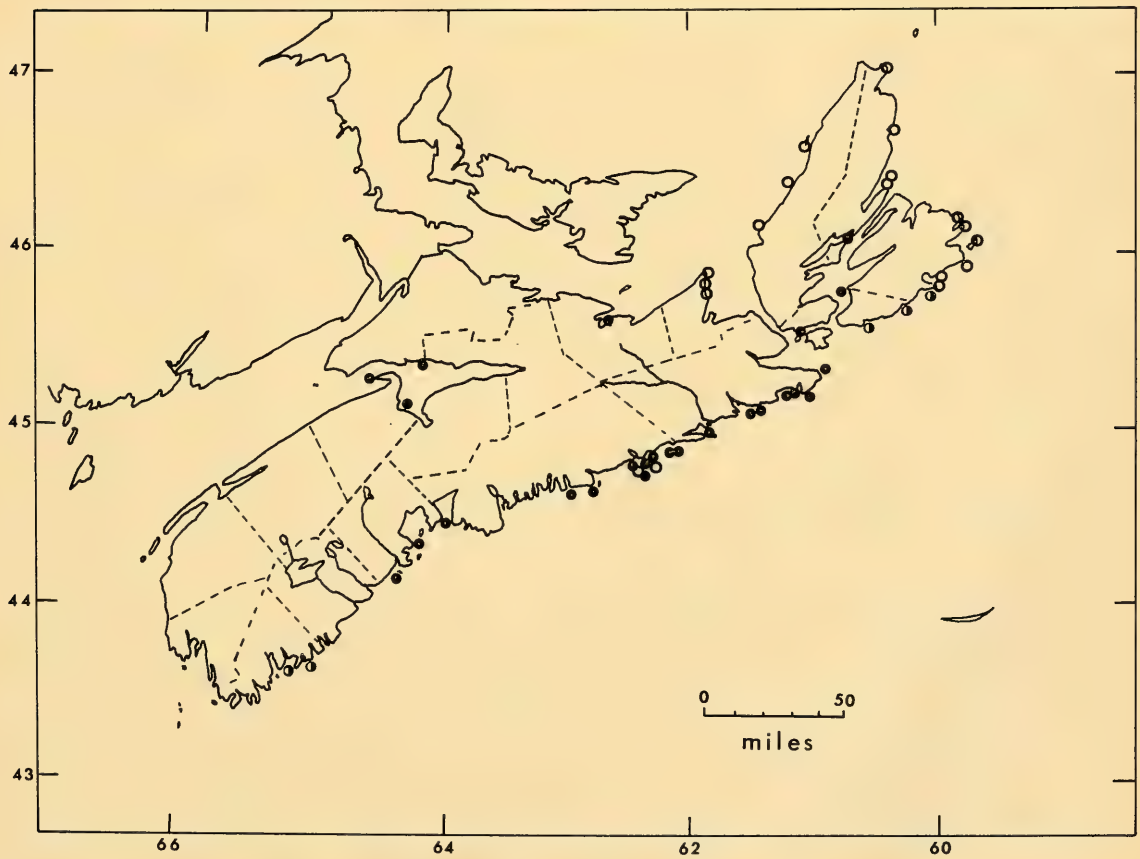

FIGURE. 1. Colonies of the Great Cormorant (open circles) and the Double-crested Cormorant (closed circles) in Nova Scotia in 1971. Half shaded circles indicate colonies in which both species breed.

Table 2. — Previous records of active nesting colonies of cormorants in Nova Scotia.

Colony Location	Number of Breeding Pairs		Year of Observation	Source
	Great Cormorant	Double-crested Cormorant		
Indian Island	–	70	1956	Lewis, 1957
Bald Island	–	40	1962	Comer (MNR, 1962)[1]
Speck Island	–	192	1956	Lewis, 1957
West Brother Island	–	147	1956	Lewis, 1957
Middle Halibut Island	–	30	1964	Clough, 1964
	–	280–300	1966	Brown, 1966a
	–	300 approx.	1967	Dobson, 1967
Tobacco Island	–	110	1957	Lewis, 1957
Crow Island	–	136	1956	Lewis, 1957
Red Island	–	present	1935 approx.	local residents
Cape Morien	73 approx.	–	1966	Alward (MNR, 1966)
Cape Perce	14+	–	1966	Alward (MNR, 1966)
Double Island	–	75 approx.	1966	Brown, 1966b
Hertford and Ciboux Islands	100	25	1925(?)	Bayley, 1925
	50	–	1935	Robbins in Erskine, 1972
	39	present	1940	Tufts, 1962
	200 adults	–	1963	Erskine, 1972
	700 adults	–	1968	Neily, pers. comm.
Money Point	–	present	1960 approx.	local residents
Cheticamp Island	20	–	1960	Alward & van Tets (MNR, 1960)
Margaree Island	23+	–	1965	Erskine, 1966
Cape George	9	–	1956	Lewis, 1957
Crystal Cliffs	–	under 50	1914	Lewis in Erskine, 1972
	–	300	1937	Peters in Erskine, 1972
	present	present	1939	Peters in Erskine, 1972
	331	–	1943	Peters in Erskine, 1972
	80	170	1944	Tufts, 1962
	18	–	1956	Lewis, 1957
	29	–	1965	Erskine (MNR, 1965)
Pictou Wharf	–	present	1944	Tufts, 1962
	–	33	1969	Holdway, 1969
	–	58	1970	Holdway, 1970
Egg Island	–	present	1944	Tufts, 1962
Boot Island	–	8–10	1967	Tufts, 1967
	–	25 approx.	1968	Coldwell (MNR, 1968)
Cape Split	–	40	1933	Tufts, 1962

[1]Comer censused an island off Owls Head which is assumed to be Bald Island.

cently, but rock slides may have obliterated nesting sites in this case. These increases in the size of many previously known colonies may indicate a recent increase in the breeding population of this species, but the discovery of 18 previously unknown colonies may be more significant of the lack of earlier data than a recent increase in the number of colonies.

Approximately 2050 pairs of *P. carbo* were counted in 23 colonies. Seven of these had been previously censused with those at Cape Perce, Cheticamp I. and Margaree I. showing slight increases while the colonies on Hertford and Ciboux Is. have grown substantially in the last decade.

The distribution of the breeding colonies of this species shown in Figure 1 is very different from that presented by Godfrey (1966). Not only have many new colonies been found along the coast of Cape Breton I. but four nesting places have been discovered on the eastern and southern Shores of mainland Nova

TABLE 3. — Records of Nova Scotian cormorant colonies, now defunct.

Colony Location	Direction to Nearest Active Colony	Number of Breeding Pairs		Year of Observation	Source
		Great Cormorant	Double-crested Cormorant		
Ram Island	11 km S.W. of Green Island, Shelburne Co.	–	44	1969	Smith (MNR, 1969)
Duck Island	3 km E.N.E. of Barren Island	–	250	1957	Lewis, 1957
Roger Island	0.5 km N. of Barren Island	–	25	1956	Lewis, 1957
Inner Halibut Island	1 km N. of Middle Halibut Island	–	present	1964	Clough, 1964
		–	few	1966	Brown, 1966a
		–	few	1967	Dobson, 1967
Monks Head	10 km S.S.E. of Crystal Cliffs	20	–	1956	Lewis, 1957

Scotia. At the southernmost breeding places, on Blue Gull I. and Green I., *P. carbo* are found with ground-nesting *P. auritus,* which make up over 90% of the birds in these colonies. It is not unexpected that *P. carbo* should breed this far south; Audubon (1840) reported them breeding at Grand Manan I. and Nuttall (1834) reported them breeding close to Boston. As so little work has been done on the seabirds breeding in this province it is not possible to say with any certainty that the number of colonies or the breeding range of this species has changed recently, but it seems improbable that all these colonies coud remain undiscovered if they had been in existence for very long. Furthermore *P. carbo* seem to compete successfully for nesting places with *P. auritus;* certainly the latter species has been replaced by the former at Crystal Cliffs and Hertford I. Thus the relatively small numbers of *P. carbo* in the Shelburne County colonies as compared with the mixed colonies in Cape Breton I. suggest a fairly recent arrival of *P. carbo* in southern Nova Scotia.

Habitat Preferences

P. carbo is exclusively a ground and cliff nester in Nova Scotia, selecting as nesting places bald rocky islets or isolated cliffs more than 15 m in height. *P. auritus* nests preferentially in spruce trees on isolated islands but it does nest on the ground either in mixed colonies with *P. carbo* or alone. Where it nests on the ground apart from *P. carbo* it is always in old colonies in which all the trees have been killed by the droppings of previous generations. Often such colony sites are abandoned and the birds move to a nearby treed island. Good exampes are the movements of colonies from Inner Halibut I. to Middle Halibut I. and from West Brother I. to Horse I. and Long I. This latter example is particularly interesting as *P. carbo* began to breed among the stumps of dead trees on Brother I. after *P. auritus* had left. There are indications that the distribution of *P. carbo* colonies is determined to some extent by presence or a absence of suitable bald islands. It is possible that *P. auritus,* by killing the trees on their nesting islands may provide nesting areas for *P. carbo,* allowing it to colonise areas that would otherwise have been closed to it. Only at Durrell Point on Prince Edward Island have *P. carbo* been recorded to nest in trees (Godfrey 1954). Here it breeds in low, dense, stunted spruces.

Association with Great Blue Herons

Of the thirty *P. auritus* colonies in this province, ten contain breeding Great Blue Herons (*Ardea herodias*). However, only twelve of

these thirty colonies have vacant living trees in them in which herons could nest. The two apparently suitable islands on which breeding herons have not been reported are Little Duck I. and Crow I. Interestingly, Egg I. has no trees suitable for nesting herons but it is associated with a hernonry on Pinnacle I. a few hundred metres distant.

Egg Survival and Fledging Success

In most cases we could not determine clutch survival as the colonies were only visited once. The junior author, however, was able to make visits to the small *P. carbo* colony off Guildford I. The mean clutch size was found to be 3.24 eggs on May 23, but by July 19 only 20 almost fledged young had survived in the 17 nests in the colony. This is an average of 1.17 young fledged per nest, a success of 36.7%. Kortlandt (1942) reported a similar fledging success; he estimated that 1.25 young were reared per nest in the Netherlands colonies of the European Great Cormorant.

Interference and Predation

Both these species show a quite low annual mortality after reaching sexual maturity (Kortlandt 1942, Hickey in Palmer 1962) and if not disturbed or persecuted should be capable of rapid population growth. However, not all colonies are as successful as the Guildford I. one. *P. carbo,* nesting mainly on bare rocks in this province, is particularly vulerable to human interference, while *P. auritus* nesting almost entirely in trees, are relatively immune. Fishermen have a strong dislike for cormorants (most cannot distinguish between the species) believing them to eat salmon and lobster and to rob fishing nets and traps. Lewis (1957) has shown that these birds do almost no economic harm. It is likely that fishermen destroyed the eggs of the *P. carbo* colony on Hay I., where 92 of the 94 nests in the colony were empty on June 8. The rather low mean clutch size of the colony on Kennington Rocks, 2.06 eggs per nest on June 6, 1971, undoubtedly reflects some human intrusion. Human intrusion causing adults to leave the nest may lead to egg and chick mortality even if nests are not wilfully destroyed. Crows, (*Corvus brachyrhynchos*) Ravens (*Corvus corax*) Herring and Great Black-backed gulls (*Larus argentatus* and *Larus marinus*) which are not normally very successful predators on cormorants, may in these circumstances successfully rob nests.

Such predation may not, however, be an inevitable consequence of human presence. In this province lobster traps are set close to all the colonies of *P. carbo* and near to many of the *P. auritus* colonies also. The daily presence of boats close to these colonies causes little disturbance; only if one sets foot on the island do birds leave their nests.

Acknowledgements

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Literature Cited

Audubon, J. J. 1840-44. The Birds of America. Vol. 1-7. New York and Philadelphia.

Bayley, I. A. 1925. The birds of Bird Islands, Nova Scotia. Canadian Field-Naturalist 39: 183-187.

Brown, R. G. B. 1966a. Eastern Shore Sanctuary *in* Society Field Trips. Nova Scotia Bird Society Newsletter 8(2): 15-16.

Brown, R. G. B. 1966b. Note *in* News of the birds, summer and early fall, 1966. Nova Scotia Bird Society Newsletter 8(3): 15.

Clough, G. C. 1964. A spring visit to the Eastern Shore Bird Sanctuary. Nova Scotia Museum Newsletter 4(1): 3-11.

Dobson, P. R. 1967. Eastern Shore Bird Sanctuary Field Trip, June 17, 1967. Nova Scotia Bird Society Newsletter 9(2): 16.

Erskine, A. J. 1966. Not strictly for the birds. N.S. Bird Society Newsletter 9(1): 25-31.

Erskine, A. J. 1972. The Great Cormorants of Eastern Canada. Canadian Wildlife Service Occasional Paper No. 14, 21 p.

Godfrey, W. E. 1954. Birds of Prince Edward Island. National Museum of Canada Bulletin 132: 155-213.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Kortlandt, A. 1942. Levensloop, samenstelling en structuur der Nederlandse aalscholverbevolking. Ardea 31: 175-280.

Lewis, H. F. 1929. The Natural History of the Double-crested Cormorant (*Phalacrocorax auritus auritus* Lesson). Ottawa: Ru-Mi-Lou Books, 94 pp.

Lewis, H. F. 1941. Breeding European Cormorants of North America. Auk 58: 360-364.

Lewis, H. F. 1957. Report on official investigation of cormorants in Nova Scotia in 1956 and 1957. Nova Scotia Museum Science Newsletter 2: 28-32.

Lowerison, E. 1972. Observations of the Double-crested Cormorant at Abercrombie, Pictou Co., N.S. 1971. Nova Scotia Bird Society Newsletter 14(2): 107-108.

Nuttall, T. 1834. Manual of ornithology of the United States and Canada. The water birds. Hilliard, Gray and Company, Boston. 627 pp.

Palmer, R. S. 1962. Handbook of North American Birds. Vol. 1. Yale University Press, New Haven and London. 567 pp.

Tufts, R. W. 1962. The Birds of Nova Scotia. Nova Scotia Museum, Halifax.

Tufts, R. W. 1967. Boot Island visited. Nova Scotia Bird Society Newsletter 9(3): 11-12.

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Notes

A Possible Shortcut Spring Migration Route of the Arctic Tern to James Bay, Canada

The chances of observing an Arctic Tern, *Sterna paradisaea*, in southeastern Ontario or southwestern Quebec have doubtless seemed so remote in the past to bird watchers that few have really looked for the species there. Most of the black-capped terns were more or less automatically ticked off as Common Terns, *Sterna hirundo*. While it is usually true that almost all such terns will prove to be Common Terns, evidence both old and new now suggests that for a short period in late May and in the first two weeks of June, Arctic Terns are to be found among the very similar Common Terns, perhaps sometimes even outnumbering them. Indeed the data brought together below strongly suggest the possibility that a heretofore unrecognized migration route of the Arctic Tern exists, extending from the St. Lawrence River inland to James Bay.

On June 11, 1972, Ronald J. Pittaway (manuscript report for submission to the Ontario Bird Records Committee) came up with a surprising observation of over 40 Arctic Terns on that date at Deschênes Rapids, Ottawa River (near Ottawa), Ontario. He watched them under frequently ideal conditions almost continuously from 10.30 a.m. to 6.00 p.m., except for a lunch hour. He observed many times the pertinent Arctic Tern field marks as the birds flew about or sat on floating logs, often allowing direct comparison with Common Terns. Several other competent observers (including Dr. D. B. O. Savile and F. M. Brigham) identified Arctic Terns there on the following day. Photographs were taken which tend to support the identification as Arctic Terns but do not completely verify the record.

A single tern, with apparently a completely blood-red bill (no dark tip), perching beside the Rideau Canal, near Carleton University, Ottawa, Ontario, on May 23, 1972, was reported by Nickolas Dederer (oral). A similar tern, perhaps the same individual, was observed there on May 26, 1972, by Dr. Lorraine Smith (oral). Although circumstances were such that neither observer was completely sure of the identification of the bird as an Arctic Tern, these observations strongly suggest that the species might have been in Ottawa as early seasonally as May 23.

On June 10 and 11, 1972, three Arctic Terns were discovered at Beauharnois, Quebec, by Mrs. Mabel McIntosh (*in litt.*), Terry Thormin, Dr. J. B. Steeves, and Stewart Holohan. Photos taken of these birds readily identify them as Arctic Terns. Beauharnois, on the St. Lawrence River, is less than 100 miles east of Ottawa and the certain presence of Arctic Terns there strongly supports the correctness of the various sight records near Ottawa on and near the same date.

There are older records that now appear to fall into a pattern. Again at Dechênes Rapids, the same locality where Pittaway made his 1972 observations of Arctic Terns, Savile (1957) identified eight Arctic Terns on June 8, 1952. In the light of the foregoing, perhaps Eifrig's (1911) half-forgotten assertion that a specimen was taken in the Ottawa region on May 30, 1909, may not seem so improbable.

In Cochrane, Ontario, an Arctic Tern was photographed on June 17, 1965 (Goodwin, 1965). In Toronto, a specimen was taken in May, 1891 (Fleming 1930). In western New York, an adult female was collected on Cayuga Lake on May 20, 1915 (Griscom 1916).

In southwestern Quebec, there is Browne's (1967) sight record of about 700 on June 11, 1961, at St. Fulgence, on the Saguenay River. Terns turning up the Saguenay from the St. Lawrence River would be headed almost straight for James Bay. A strong indication that Arctic Terns are no strangers inland in the ornithologically little known country between the Saguenay River and the foot of James Bay is a specimen collected at Gull Lake, Quebec, some 150 miles southeast of James Bay, on June 8, 1914, and recorded by Todd (1963).

For Arctic Terns nesting in James Bay, for example, a spring migration route from the upper St. Lawrence overland to James Bay would seem to offer definite advantages over either a strictly marine route through Hudson Strait or a flight across the vast Quebec-Labrador Peninsula. Compared with the former, a St. Lawrence River to James Bay route would be four times shorter (500 vs. over 2000 miles). Compared with the latter,

it offers abundant open water and presumably adequate availability of food sources as opposed to winter ice and snow conditions that obtain in early June in the bleak interior of the Quebec-Labrador Peninsula.

Needless to say, there is no information as to how Arctic Terns reach these inland points mentioned. Perhaps most travel up the St. Lawrence River from the Atlantic Ocean via the Gulf of St. Lawrence, although the single records from Toronto, Ontario, and Cayuga Lake, New York, respectively, might possibly suggest a route directly inland from the Atlantic Ocean.

This offers an opportunity for bird watchers to make a useful contribution to a clearer understanding of the problem by carefully examining all the black-capped terns encountered in the areas concerned, especially in the period from late May through the first two weeks in June. If Arctic Terns are observed on this shortcut route, the writer would greatly appreciate being informed of dates and localities as well as details concerning the identification of the birds observed.

Literature cited

Browne, Peter. 1967. Status of birds, Lake St. John region, Quebec. The Canadian Field-Naturalist 81(1): 50-62.

Eifrig, C. W. G. 1911. The birds of Ottawa. Ottawa Naturalist 24: 152-163, 176-187, 198-206, 222-228.

Fleming, J. H. 1930. Ontario bird notes. The Auk 47(1): 64-71.

Goodwin, Clive E. 1965. Ontario — western New York region. Audubon Field Notes 19(5): 539.

Griscom, Ludlow. 1916. The Arctic Tern in central New York. The Auk 33(3): 319.

Savile, D. B. O. 1957. Some recent Ottawa bird records. The Canadian Field-Naturalist 71(1): 32-33.

Todd, W. E. Clyde. 1963. Birds of the Labrador Peninsula and adjacent areas. University of Toronto Press, Toronto. I-XIV, 1-819.

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Range Extension of the Dolly Varden, *Salvelinus malma* (Walbaum), in Alberta

The presence of trout in the Peace River in Alberta has been known by local residents for some time, however, their identification and presence in the river has never been officially verified. Since 1967 the author has caught one Dolly Varden, *Salvelinus malma* (Walbaum), seen and measured two others and heard from reliable sources of four more caught near the town of Peace River (56° 14′ N; 117° 26′ W). The northern-most occurrence of a Dolly Varden was the one caught by the author on May 7, 1969 in a small tributary of the Peace River about 40 miles north of the town of Peace River (56° 44′ N; 117° 10′ W). This specimen, an immature male, measured 51.8 cm. (Fork length) and weighed 1075 grams and was three years old. The previous northern range recorded for the Dolly Varden in Alberta was from the headwaters of the Wapiti River, approximately 130 miles south of the new record. Neither Paetz and Nelson (1970) nor McPhail and Lindsey (1970) recorded Dolly Varden in the Alberta portion of the Peace River, although both mention that Dolly Varden are known in its headwaters.

Dolly Varden could have invaded the Alberta portion of the Peace River either from the headwaters in British Columbia or from the Wapiti River in Alberta. Since the closure of the gates of the W. A. C. Bennett Dam on the Peace River in British Columbia in 1967, the Peace River has been blocked to any further migrations of fishes into Alberta.

Literature cited

McPhail, J. D. and **C. C. Lindsey.** 1970. Freshwater Fishes of Northwestern Canada and Alaska. Bulletin 173. Fisheries Research Board of Canada, Ottawa. 381 pp.

Paetz, M. J. and **J. S. Nelson.** 1970. The Fishes of Alberta. Government of Alberta, Queen's Printer, Edmonton. 282 pp.

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A Restricted Habitat for Mushrooms (Agaricaceae) in the Mackenzie River Delta, Northwest Territories

The *Salix alaxensis–Equisetum arvense* successional community in the Mackenzie River Delta occurs primarily on the convex bank of shifting channels where young levees are rapidly aggrading due to sediment accumulation during the spring flood. Such levees annually receive 8-10 cm of alluvium which contracts upon drying to form desiccation cracks (Figure 1).

FIGURE 1. Dessication crack 40 cm deep in sediment on a rapidly aggrading slipoff slope in the Mackenzie River Delta. Note the layers of organic material.

An interesting feature of this community is the presence of three mushrooms of the family Agaricaceae (genera *Inocybe, Omphalina,* and *Cortinarius*), which grow in the cracks that bisect the shrinking sediment. These fungi form mycelia, but they do not develop to a mature stage, partly because fructifications can not develop until post-flood drainage is complete in early July (the species are thus immature and can not be identified). At this time, new cracks expose a portion of the buried layer of the previous year's dead leaves and other organic matter that also contain mycelia, especially of *Omphalina* species. These agarics then grow on the exposed decaying ligneous material. They probably form a mycorrhizal relationship with the roots of *Salix alaxensis* which are also exposed by desiccation cracks at this time. In the study area (northeast-central Mackenzie Delta) *Omphalina* species are found only in the *Salix alaxensis – Equisetum arvense* community where they grow exclusively in desiccation cracks (Figure 2). A simple geomorphic process is thus largely responsible for the presence of one of the more characteristic members of this community.

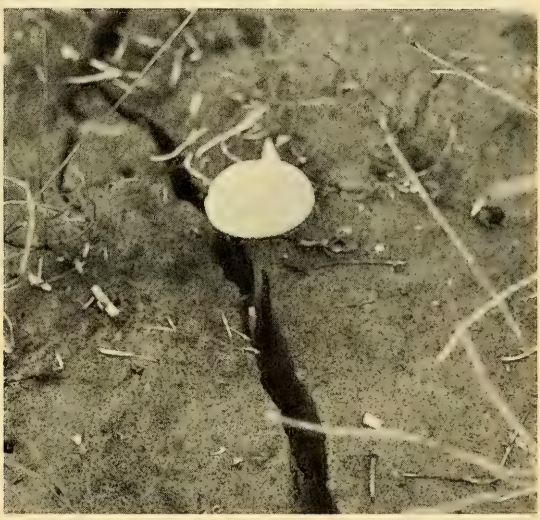

FIGURE 2. One of the mushrooms (*Omphalina* sp.) that grow only in desiccation cracks in the *Salix alaxensis – Equisetem arvense* community of the Mackenzie River Delta.

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Appreciation is expressed to V. J. Krajina, Department of Botany, University of British Columbia, for his critical review of this information, and to R. J. Bandoni, of the same department, for identifying the agarics. Voucher specimens are deposited in the University herbarium.

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Lonicera maackii (Caprifoliaceae) Adventive in Ontario[1]

Abstract:. Lonicera maackii (Rupr.) Maxim., a species native to Asia, has become established as a wild plant at several localities near Hamilton, Ontario.

Lonicera maackii (Rupr.) Maxim., the Amur Honeysuckle (Figure 1), is native to northeastern

FIGURE 1. *Lonicera maackii.*

Asia, and is frequently cultivated as an ornamental in North America. This species has evidently only rarely spread from cultivation on this continent. Braun reported in 1961 that *L. maackii* was "becoming abundant in pastures and woodlands" in Hamilton County, Ohio (Cincinnati region), but was not known as a wild plant elsewhere in the state. In 1971, J. W. Thieret discovered *L. maackii* as an apparent escape from cultivation on South Bass Island in Lake Erie, Ottawa County, Ohio (specimen in herb. F. T. Stone Laboratory, Put-in-Bay, Ohio). *L. maackii* has also been reported to occur as a "waif" in Chesterfield County, Virginia (Uttal and Mitchell, 1972)

Neither Boivin's (1966) *Énumération des Plantes du Canada* nor Rousseau's (1971) *Classification de la flore synanthropique du Québec et de l'Ontario* contains any record of *L. maackii* as a wild plant in Canada. In the vicinity of Hamilton, Ontario, however, obviously spontaneous plants of this species occur in several localities. Herbarium records date back to 1955, the earlier collections having been misidentified as *L. xylosteum* L. In Ontario, as in Ohio, *L. maackii* is found in both open and wooded habitats.

As indicated in Figure 2, *L. maackii* has been collected at several localities in the Royal Botanical Gardens' natural areas above the north and east shores of Coote's Paradise marsh, Wentworth County (voucher specimens: *Tamsalu 5275* through *5280,* HAM; *Pringle 1334,* HAM, MICH, NY, OS, RSA; *1335,* HAM; *1337,* HAM; and *1339,* DAO, HAM). *L. maackii* has also been found along Valley Inn Road, on the opposite slope of the sandbar dividing Coote's Paradise from Hamilton Harbour (*Pringle 1338,* DAO, HAM, MICH, OAC) and near Patterson Road, ca. 2.6 km north of the Coote's Paradise population (*Pringle 1117,* HAM, LKHD; *Pringle 1336,* DAO, HAM). Herbarium designations follow Lanjouw and Stafleu (1964), with the addition of LKHD for the herbarium of Lakehead University.

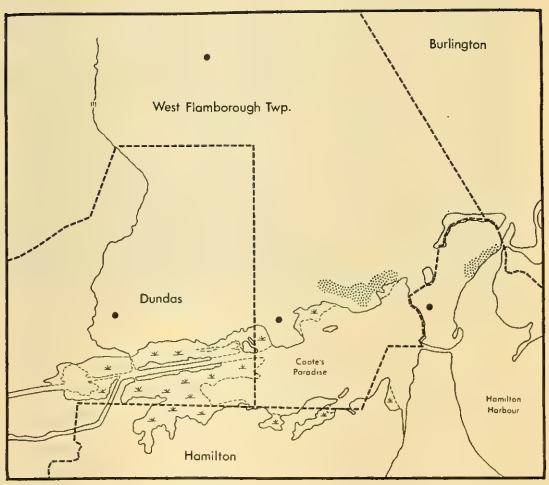

FIGURE 2. Distribution of *Lonicera maackii* in the Hamilton, Ontario, region. Stippled areas: numerous plants; dots: isolated plants or small colonies.

Lonicera maackii was probably originally introduced into the Hamilton area as a cultivated ornamental. Some of the localities at which this species now occurs may be near the sites of early plantings. With regard to the presence of *L. maackii* on the properties of the Royal Botanical Gardens, however, records indicate that this

[1]Contribution No. 13 from the Royal Botanical Gardens, Hamilton, Ontario.

species was first cultivated at the Gardens in 1954, and that the only planting of this species outside the nursery was the placement of two plants in the *Rhododendron* collection in 1966. Since herbarium records indicate that a number of evidently spontaneous colonies were established by 1955, the occurrence of *L. maackii* in the Gardens' natural areas obviously antedates its being planted by the Gardens. The present abundance of plants in the Hamilton area, and some occurrences of colonies or individuals in sites relatively remote from cultivated areas, wildlife-management plantings, or other locations at which it might have been deliberately introduced, clearly indicate that *L. maackii* is becoming established as a component of the spontaneous flora. Since, like the widely and abundantly naturalized *L. tatarica* L., *L. maackii* is very hardy (Sherk and Buckley, 1968), successful in diverse habitats, and evidently adapted to dissemination by birds, additional reports of *L. maacki* as a naturalized species in Canada may be expected.

Among the native and naturalized shrubby species of *Lonicera* in eastern Canada which have paired flowers on axillary peduncles, *L. maackii* can readily be distinguished by its combination of hollow branches with brown pith; long-acuminate leaf blades mostly 5-9 cm long; and peduncles generally less than 6 mm long.

Literature Cited

Boivin, B. 1966. Énumération des plantes du Canada. II — Lignidées. Le Naturaliste Canadien 93: 371-437.

Braun, E. L. 1961. The Woody Plants of Ohio: Trees, Shrubs, and Woody Climbers Native, Naturalized, and Escaped. Ohio State University Press, Columbus, 362 pp.

Lanjouw, J., and **F. A. Stafleu.** 1964. Index Herbariorum. Part I. The herbaria of the world, ed. 5. Regnum Vegetable Vol. 31, vi + 251 pp.

Rousseau, C. 1971. Une classification de la flore synanthropique du Québec et de l'Ontario. II. Liste des espèces. Le Naturaliste Canadien 98: 697-730.

Sherk, L. C., and **A. R. Buckley.** 1968. Ornamental Shrubs for Canada. Research Branch, Canada Department of Agriculture, Publication 1286. 187 pp. + 2 maps.

Uttal, L. J., and **R. S. Mitchell.** 1972. Admendments to the flora of Virginia — II. Castanea 37: 96-118.

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A Barnacle Goose in New Brunswick

On May 10, 1972 at a point along the St. John River and the Trans-Canada Highway 2.9 miles downstream from McGowan's Corner, Sunbury County, New Brunswick, a Barnacle Goose, *Branta leucopsis,* was observed and identified at 6.45 p.m. Atlantic Daylight Saving Time. The bird was among a group of 26 Canada Geese, *B. canadensis,* resting on the water 100 to 125 feet from the observers; this distance was later checked on the scale of a telephoto lens. The birds made no attempt to move away and were observed for two periods of over 15 minutes each by the authors who are experienced observers. Peterson (1947: A Field Guide to the Birds. Houghton Mifflin Company, Boston) was used at the time of observation to confirm the identification of the Barnacle Goose.

The geese were seen in a location that was heavily flooded. The spring freshets covered grazing areas which the migrating geese might otherwise have used. Thus the geese were within easy viewing distance from the highway. By early morning the following day the birds had moved away and the Barnacle Goose was not seen again. There is no other record of the occurrence of a Barnacle Goose in New Brunswick.

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Range Extension of the Blunt-lobed Woodsia, *Woodsia obtusa* (Spreng.) Torr. (Polypodiaceae), in Canada

Abstract: A colony of about 200 clumps of *Woodsia obtusa* (Spreng.) Torr. discovered in Gatineau Park, Gatineau Co. Quebec constitutes the second location for the species in Canada. Because of the peculiar and probably overlooked habitat occupied by this fern it is suggested that the species may be more frequent in southern Quebec than formerly suspected, and may occur in similar situations in eastern Ontario. Other Canadian reports are discussed.

While searching for *Cryptogramma Stelleri* (Gmel). Prantl, on the Eardley escarpment, a part of the southern edge of the Canadian Shield, I came across a large colony of the Blunt-lobed Woodsia (*Woodsia obtusa* (Spreng.) Torr.). The plants were growing in lightly shaded areas, rooted either at the base or in damp cracks on the southern side of rocks or small cliffs. These rocks were in the slope near the crest of the escarpment at an elevation of 800 feet.

Although the area is primarily precambrium, two factors seemed to allow the *Woodsia* to survive out of its normal range. The rocky south-facing slope has a southern character. The common trees which shade the area, Butternut Hickory (*Carya cordiformis* (Wang) K. Koch), Red Oak (*Quercus rubra* L.) and Butternut (*Juglans cinerea* L.), are all near their northern limit here. Also the runoff of rainwater on the slope causes a buildup of calcareous debris to form, particularly below large rocks. This is demonstrated by the large amounts of *Cryptogramma* in the dampest seepage area. The exposed rocks have large clumps of *Woodsia ilvensis* (L.) R.Br. growing on them, often close to clumps of *Woodsia obtusa* (Spreng.) Torr. Other ferns growing with the Blunt-lobed Woodsia are *Asplenium Trichomanes* L. and *Cystopteris fragilis* (L). Bernh. The Blunt-lobed Woodsia is probably overlooked in the Canadian portion of its range because of the local nature of suitable habitat and possibly also its similarity to *Cystopteris fragilis* (L.) Bernh., with which it might at first be confused.

John Macoun (1890) in his *Catalogue of Canadian Plants* cites three records for Canada. The two records from British Columbia have been revised to *Woodsia oregana* D. C. Eaton var. *Lyallii* (Hooker) Boivin (= *W. scopulina* D. C. Eaton), (Boivin, 1967). The record from Nova Scotia was apparently based on a plant which was planted with several other introduced species (Boivin *in litt.*). There is also a specimen from Port Arthur, Ontario, in the herbarium of the University of Toronto which is now considered to be incorrectly labeled. This specimen, and one of the rare coastal fern *Schizaea pusilla* Pursh., also labeled Ontario, apparently became mixed up with exchange material from eastern United States. (Boivin pers. comm.)

The only other location for *W. obtusa* (Spreng.) Torr. in Canada is in the vicinity of St. Armand, Missisquoi County, Quebec (Brown, 1964; Rouleau, 1947), where it was first discovered in 1935 or 1936 by Mr. Paul Belval and Mr. Marcel Raymond. Near St. Armand the *Woodsia* occurs on an outcrop of dolomite which extends into south-western Quebec from the Appalachians in Vermont (Camille Rousseau *in litt.*).

Specimens from Gatineau Co., Quebec have been deposited in DAO (Lafontaine No. 7 and 9, July 4 and 6, 1972). The location is 5 miles due north of Aylmer, Quebec. The exact locations of the specimens are Latitude 45°28′6″, Longitude 70°50′51″ and Latitude 45°28′5″, Longitude 75°50′ 41″.

Acknowledgements

I wish to thank Dr. Bernard Boivin of the Plant Research Institute for information on the history of the Canadian records of *Woodsia obtusa* (Spreng.) Torr.

Literature Cited

Boivin, B. 1967. Soustractions de Colombie Britannique. Le Naturaliste Canadien 94: 642.

Brown, D. F. M. 1964. A Monographic Study of the Fern Genus *Woodsia*. Beihefte zur Nova Hedwigia. Heft 16: 121.

Macoun, J. 1890. Catalogue of Canadian Plants. Part 5. Geological and Natural History Survey of Canada. p. 283-284.

Rouleau, E. 1947. Supplement à la Flore Laurentienne. Frères des Ecoles Chrétiennes, Montréal. p. 59.

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The Migration of Sabine's Gulls, *Xema sabini,* in the Northwest Atlantic

Abstract. This paper lists sightings of Sabine's Gulls, *Xema sabini,* by the author, and by observers of the PIROP seabird scheme, from research ships in the northwest Atlantic. Some observations by shore-based observers are also added.

In spring, the first birds arrive off Newfoundland, southern Labrador, and west Greenland in the last week of May. The birds become fairly common at the edge of the ice off Labrador; the highest total seen was 77 birds at 56°44'N 58°00'W on June 2, 1970. They move at a leisurely speed northwest along the edge of the ice, and probably reach their breeding grounds in mid-June.

Fall migration takes place mainly in August and September. Birds from the Canadian Arctic probably cross to west Greenland to join local birds there. They then probably move southeast to the coast of west and southwest Europe, before moving south to winter off southwest Africa. However, sightings from New England, the east coast of Canada and the Great Lakes about this time suggest that at least part of the population moves overland to the Atlantic.

Non-breeding Sabine's Gulls, both adults and immatures, are occasionally found in the northwest Atlantic in late June and in July.

Introduction

On two cruises on a German fisheries research vessel, I have had the opportunity to record Sabine's Gulls, *Xema sabini,* far off the coasts of Labrador, Baffin Island, and west Greenland. Since so little is known of the movements of this species in the northwest Atlantic, it seems worth publishing these records. My sightings are listed in Table 1. I have added records collected by Canadian observers taking part in the PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques) seabird scheme. I have also added some recent sightings of Sabine's Gulls by shore-based observers in New England and eastern Canada; the additional list is not intended to be exhaustive, but to supplement the observations made at sea.

Spring migration

The Pacific population of Sabine's Gulls breeds in Siberia and the western American Arctic and winters off Peru and Ecuador (Chapman, 1969). The Atlantic population winters mainly off South Africa and South-West Africa and crosses the northern Atlantic in May. The first birds arrive off Newfoundland, Labrador and west Greenland during the last week of May. There are nearly simultaneous records of birds near the edge of the drift ice on Hamilton Inlet Bank off Labrador (May 27-29, 1970), and on the southern Grand Bank (May 24, 1970), as well as a single adult, moving northwest, off the southwest Greenland coast on May 25, 1969. It is possible to date the spring arrival fairly precisely; R. G. B. Brown (personal communication) was on the Hamilton Inlet Bank up to May 17, 1969 and May 8, 1970, without seeing any Sabine's Gulls.

Most of the migrants seem to arrive a few days later, and there are many records of single birds and small flocks during the first half of June from the Davis Strait and also from the Labrador Banks north of Hamilton Inlet. The birds which I saw off Labrador were all close to the edge of the drift ice, and moving northwest. One would suppose that this direction of movement is maintained all the way up from their winter quarters. However, the bird seen on June 6, 1971 in the Gulf of St. Lawrence suggests that some birds may detour, and perhaps move on north through the Strait of Belle Isle. Alternatively, this bird might have continued northwest overland, in the direction of Hudson Bay.

These data suggest that the main spring migration is over by the middle of June. This agrees with the known arrival dates of Sabine's Gull on its breeding grounds — for example, early June in Greenland (Salomonsen, 1967).

I was surprised to observe that, with a few exceptions, the migrating birds showed no sign of haste. As long as fish offal was available the Sabine's Gulls would fly around the ship for hours feeding on it, in the same way that Northern Fulmars, *Fulmarus glacialis,* and Black-legged Kittiwakes, *Rissa tridactyla,* do. But most of them were resting on the edge of the drift ice, either on the water or on the ice itself. The swimming birds would pick for food among the abundant drifting seaweed at the ice edge, or in pools enclosed by drift ice. The birds on the ice seemed to prefer long tongues of it, nearly surrounded by water. The gulls were often seen in association with Arctic Terns, *Sterna paradisaea,* though the terns were much more numerous.

It is possible that the birds migrate by night, or in the early morning or late evening, and use the day for feeding and resting, so that this appearance of laziness during migration is only an illusion. Brown *et al.* (1967) note that many Sabine's Gulls arrived already paired on their breeding grounds in Alaska, so the birds could be performing part of their courtship while still on migration.

TABLE 1. — Sightings of Sabine's Gulls in the northwest Atlantic.

Date	Number	Position	Source*
Labrador coast			
27 May 1970	1 adult	53°44′N 52°10′W	KL
28 May 1970	13 adults	54°05′N 52°56′W	KL
29 May 1970	1 adult	54°24′N 53°27′W	KL
30 May 1970	2 adults	55°07′N 53°29′W	KL
31 May 1970	2 adults	56°18′N 57°38′W	KL
1 June 1970	4 adults	56°14′N 57°29′W	KL
2 June 1970	77 adults	56°44′N 58°00′W	KL
3 June 1970	30 adults	58°51′N 58°58′W	KL
4 June 1970	10 adults	56°23′N 57°37′W	KL
5 June 1970	7 adults	56°15′N 57°30′W	KL
6 June 1970	1 adult	56°21′N 57°39′W	KL
7 June 1970	1 adult	56°19′N 57°31′W	KL
8 June 1970	1 adult	56°10′N 56°51′W	KL
15 June 1969	11 adults	59°18′N 59°01′W	KL
16 June 1969	2 adults	55°51′N 56°28′W	KL
29 June 1970	1 adult	59°08′N 58°54′W	KL
30 June 1969	1 adult	56°08′N 57°47′W	KL
22 July 1970	1 adult, 1 immature	56°16′N 57°33′W	KL
23 July 1970	1 immature	56°15′N 57°31′W	KL
Hudson Strait			
25 Aug. 1971	2 adults	63°33′N 74°52′W	PIROP
Davis Strait, Baffin Bay and west Greenland			
25 May 1969	1 adult	59°57′N 50°02′W	KL
3 June 1969	1 adult	66°32′Y 56°10′W	KL
5 June 1969	4 adults	64°26′N 58°24′N	KL
6 June 1969	3 adults	64°12′N 59°06′W	KL
7 June 1969	10 adults	63°23′N 60°33′W	KL
8 June 1969	1 adult	62°43′N 60°48′W	KL
9 June 1969	2 adults	64°00′N 58°50′W	KL
10 June 1969	3 adults	64°20′N 59°10′W	KL
11 June 1969	9 adults	64°24′N 58°10′W	KL
14 June 1969	4 adults	62°25′N 59°38′W	KL
19 Aug. 1971	1 adult	64°59′N 62°21′W	PIROP
29 Aug. 1971	1 immature	63°16′N 61°18′W	PIROP
3 Sept. 1970	1 adult	64°02′N 53°20′W	PIROP
4 Sept. 1970	1 ?	63°47′N 55°45′W	PIROP
5 Sept. 1970	1 immature	63°43′N 59°45′W	PIROP
7 Sept. 1970	1 immature	66°42′N 54°38′W	PIROP
9 Sept. 1970	1 immature	73°19′N 73°02′W	PIROP
Gulf of St. Lawrence			
6 June 1971	1 adult	48°29′N 61°28′W	PIROP
30 Sept. 1971	2 immatures	Eel River, Restigouche Co., New Brunswick	AB
Atlantic waters off Newfoundland and Nova Scotia			
24 May 1970	1 adult	43°02′N 50°11′W	PIROP
27 Aug. 1969	1 adult	Sable Island, Nova Scotia	NSBS (1969)
18 Sept. 1970	1 immature	44°55′N 57°31′W	PIROP
Northeast New England and Bay of Fundy			
23 June 1968	1 adult	Matinicus, Maine	AFN
11 July 1971	1 subadult	Rockland, Maine	AB
8 Sept. 1968	1 adult	Isles of Shoals, New Hampshire	AFN
30 Sept. 1969	3 adults	10 miles west of Yarmouth, Nova Scotia	NSBS (1970)
Sept. 1971	1 ?	Grand Manan I., New Brunswick	CET
Oct. 1971	1 ?	Deer I., New Brunswick	CET

However, I saw no evidence of paired birds.

The concentration of birds at the edge of the ice at first suggests that the ice might be a barrier to their migration, but in fact those birds which breed in Baffin and Ellesmere Islands must eventually cross a zone of ice which in May and June is often as much as 100 miles wide.

Summer distribution

Up to the middle of June, records of Sabine's Gulls in these waters are clearly of birds on spring migration, but it is hard to believe that those which I saw in late June and early July off Labrador could have been breeding. Presumably these are birds which have lost their eggs and deserted the breeding area, or which perhaps were delayed on migration.

The single one-year-old bird (presumably the same individual) seen off Labrador on July 22 and 23, 1970 is particularly interesting. The date is much too early for it to have been a newly fledged bird. The same is true of an immature female taken on July 10, 1934 at Bay of God's Mercy, Southampton Island (Stresemann and Stresemann, 1966). One-year-old birds do leave the wintering area off South Africa, but it seems that they usually do not go farther than the waters of the tropical Atlantic — for example, off West Africa (Lambert, 1969b.) However, these records and that of a subadult off the Maine coast on July 11, 1971 suggest that some birds may move north towards the breeding grounds. But in general it is clear that the occurrence of either immature or adult Sabine's Gulls in the northwest Atlantic in summer is a rare phenomenon.

Fall migration

In the northwest Atlantic, the fall migration of Sabine's Gulls takes place mainly in August and September. I have never seen Sabine's Gulls in the Labrador Sea and Davis Strait area at this time, though I spent several weeks there from early August to mid-September, 1968. However, PIROP observers have scattered records, all of single birds, from close to the west Greenland coast in early September; other records, from Baffin Bay and Davis and Hudson Straits, show that birds from the eastern Canadian Arctic are probably crossing to Greenland. Salomonsen (1967) confirms the species' presence off west Greenland at this time, and notes that there are even single records for October and November.

After they leave the northwest Atlantic, Sabine's Gulls apparently move southeast, and appear in large numbers off the coasts of west and southwest Europe (e.g. Ricard, 1966 and Sharrock, 1971). From there they continue their migration along the west African coast; they begin to reach the waters off South-West Africa at the end of September, and remain there until spring migration starts again in March (Lambert, 1967, 1969a.)

Not all of the Atlantic population of Sabine's Gull follows the fall migration pattern described so far. Table 1 shows that there are a number of sightings during this period from the coasts of New England and eastern Canada. It is possible that these birds have moved south down the Labrador coast, but it seems much more likely that they have migrated overland from the Arctic. In this connection, it is interesting that four birds were seen in western Lake Ontario on September 14, 1968 and one at Madison, Wisconsin on September 22 of that year (Audubon Field Notes, 1969, 23: 44 and 55), while a single bird was seen near Montreal on September 12-13, 1970 (American Birds, 1971, 25: 34).

Acknowledgements

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Literature Cited

Brown, R. G. B., Blurton Jones, N. G. and **Hussell, D. J. T.** 1967. The breeding behaviour of Sabine's Gull *Xema sabini*. Behaviour 28: 110-140.

Chapman, S. E. 1969. The Pacific winter quarters of Sabine's Gull. Ibis 111: 615-617.

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*Sources

KL	author's observations.
PIROP	observations by PIROP observers.
CET	C. E. Tull, personal communication.
AFN	Audubon Field Notes (1969) 23: 20.
AB	American Birds (1971) 25: 832
NSBS (1969)	Nova Scotia Bird Society newsletter 11:112. 1969.
NSBS (1970)	Nova Scotia Bird Society newsletter 12:17. 1970.

Lambert, K. 1967. Beobachtungen zum Zug und Winterquartier der Schwalbenmöwe (*Xema sabini*) im östlichen Atlantik. Vogelwarte 24: 99-106.
Lambert, K. 1969a. Schwalbenmöwen (*Xema sabini*) im April und Mai 1968 vor Südwest- und Südafrika. Vogelwarte 25: 49-52.
Lambert, K. 1969b. Sommerbeobachtungen einjähriger Schwalbenmöwen (*Xema sabini*) im tropischen Atlantik. Journal für Ornithologie 110: 219.
Ricard, M. 1966. Observation des Mouettes de Sabine (*Larus sabini*). L'Oiseau 36: 64-65.
Salomonsen, F. 1967. Fuglene på Grønland. Copenhagen.
Sharrock, J. T. R. 1971. Scarce migrants in Britain and Ireland during 1958-67. Part 5: Pectoral Sandpiper, Sabine's Gull and American land-birds. British Birds 64: 93-113.
Stresemann, E. and **Stresemann, V.** 1966. Die Mauser der Vögel. Journal für Ornithologie 107, Supplement.

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Occurrence of a Northern Fur Seal near Wainwright, Alaska

In early September 1969, Frederick Ahmaogak, an Eskimo hunter from Wainwright, Alaska, killed a female northern fur sea (*Callorhinus ursinus*) on the north Alaska coast about 65 kilometers southwest of Wainwright at approximately 70° 16′ N, 161° 15′ W. I am familiar with only four other records of fur seals having been collected along the Alaskan and Canadian arctic coasts this far from their normal migration route along the Pacific coast. They are: a female at Point Barrow (71° 24′ N, 156° 27′ W) August 17, 1897 (Stone 1900); an emaciated male from a Yukon Territory freshwater lake (68° 48′ N, 136° 42′ W) about October 1, 1951 (McEwen 1954); a young animal near Letty Harbour, Northwest Territories (69° 50′ N, 124° 24′ W) October 16, 1958 (Radvanvi 1960); and an adult near Bathurst Inlet (66° 50′ N, 108° W) in 1958 (Unpublished manuscript, "Occurrence of marine mammals along the Arctic coasts of Canada" by A. W. Mansfield). Only a few residents of the marine mammal hunting villages of Point Hope, Wainwright, Barrow, and Kaktovik (Barter Island) on Alaska's northwest and north coast are familiar with fur seals, which they say occur here only rarely. The only other instance that an old man at Wainwright can recall of a fur seal being killed there was in 1942.

The fur seal killed in 1969 was on a sand mainland beach of a lagoon formed by long, narrow barrier islands. It was emaciated and had four intact eider duck legs and feet in its stomach. Normal foods are fish and squid (Pike et al. 1962). The skin measured 117 centimeters from nose to tip of tail after being stretched to an oval shape and dried. The skull, which is in the collection of the Naval Arctic Research Laboratory at Barrow, Alaska, has a condylobasal length of 178 millimeters and a zygomatic width of 98 millimeters. Age as determined by annual growth ridges on upper canine teeth (Scheffer 1950) is 4 years.

Literature Cited

McEwen E. H. 1954. A sporadic occurrence of an Alaskan fur seal. Journal of Mammalogy 35 (3): 444.
Pike, G. C., W. E. Ricker, D. G. Chapman, C. E. Abegglen, V. B. Scheffer, and **F. Wilke.** 1962. Report on food habits of fur seals in the eastern Pacific in Report on North Pacific Fur Seal Investigations from 1958 to 1961 presented to the North Pacific Fur Seal Commission on 26 November, pp. 17-18.
Radvanyi, A. 1960. Off-course migration of a northern fur seal. Journal of Mammalogy 41 (2): 277.
Scheffer, V. B. 1950. Growth layers on the teeth of Pinnipedia as an indication of age. Science 112: 309-311.
Stone, W. 1900. Report on the birds and mammals collected by the McIlhenny Expedition to Pt. Barrow, Alaska. Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 4-49.

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The Lesser Black-backed Gull in the Canadian Arctic

The Lesser Black-backed Gull (*Larus fuscus*) is known from few localities in North America and almost without exception the observations have come from eastern coastal areas during the fall, winter, or spring. There were no accepted records of this species from Canada when Godfrey published The Birds of Canada (National Museum of Canada, Bulletin No. 203, 1966), but in the interim Godfrey (personal communication) has accepted a record of one bird from Churchill, Manitoba; a fall record of a single bird from Ottawa, Ontario; a winter record of one bird from Hamilton, Ontario; and a record of a single individual at Digby, Nova Scotia in two successive autumns.

At approximately 22:30 on 17 July 1972 the presence of a dark-backed gull was brought to our attention by Gary Jones. The single bird, in the company of three Thayer's Gulls (*Larus thayeri*) and 15 to 20 Glaucous Gulls (*Larus hyperboreus*), was standing on the ice-bound surface of Char Lake opposite Arctic Outpost Camp just west of Albert Edward Bay, Victoria Island, Northwest Territories, Canada. The bird was continuously observed in short flights and standing, usually slightly apart from the other gulls, on the ice and separated from the observers (which included Connie and Bill Meyer of Cincinnati) by 75 to 100 yards of open water. The period of observation was more than 90 minutes during which time all characters were seen and discussed by all the party members with special attention being paid to the color of the legs and feet. All observations were recorded on the spot and the available references of Pough (Audubon Water Bird Guide, Doubleday Co., Inc., Garden City, N. Y., 1951, pp. 267-268) and Peterson (A Field Guide to the Birds, Houghton Mifflin Co., Boston, 1947, pp. 247-248) were consulted.

The bird was smaller than the Glaucous Gulls, but almost identical in size to the Thayer's Gulls. It was an adult with a red spot near the tip of the yellowish lower mandible. The eye-ring was red and the iris yellow. The mantle and wings were dark slate-black, and the trailing edges of the wings were white-tipped. The outermost primary had a white spot just proximal to the tip and the next primary had a smaller white spot. The head, neck, rump, tail, and underparts were white. *The legs and feet were yellow*. The gull was identified as a Lesser Black-backed Gull.

The bird was viewed in the strong, but somewhat reddish, light of the low-angled midnight sun with 7X35 and 10X50 binoculars and a 15 to 60X zoom spotting scope. With the latter the details of color of the mandibles, eye-ring, iris, feet and legs were easily discerned. A color photographic record was made of the bird with both still and movie cameras equipped with 400 mm. lenses. It was not possible to collect the specimen.

The area was baited daily with fish entrails the four successive days we remained at Arctic Outpost in hopes of securing additional photographs from closer range and under better lighting conditions, or the specimen itself. Though the camp's gull population increased from approximately 30 birds the first day of feeding to well in excess of one hundred by the fourth, the black-backed gull never returned.

The possibility of occurrence in this region of North America of other species similar in appearance to the Lesser Black-backed Gull such as the Western Gull (*L. occidentalis*), the Slaty-backed Gull (*L. schistisagus*), or one of the very dark-backed races of the Herring Gull found in the interior of Siberia (i.e., *L. argentatus heuglini*) was considered However, the Western Gull and most races of the Herring Gull have a yellow eye-ring in adults, not red as in our bird. These species also have pinkish legs and feet as adults with the exception of the yellow-footed race of the Western Gull (*L. o. livens*) in the Gulf of California, which would be far less likely than a trans-Atlantic visitor. The Slaty-backed Gull has a dark back, reddish eye-ring, and *pinkish* legs. The field marks observed on our bird effectively eliminated these similar species as far as was possible without having the specimen in hand. The very dark mantle of this bird would also tend to remove the Slaty-backed and Herring Gulls as possibilities. W. Earl Godfrey examined our photographs, some of which show the black-backed gull standing with a Glaucous Gull thus allowing a comparison of both size of the bird and color of the mantle. Godfrey writes, "If the photos accurately show the color of the mantle, I doubt that the mantle of either *L. a. heuglini* or *L. schistisagus* is ever that dark. The darkness of the mantle indicates that the bird was *Larus fuscus fuscus* rather than the paler backed *Larus fuscus graellsii*". We also believe the bird was the darker-backed race, *L. f. fusucs,* the northernmore of the two races.

1972 was a most unusual year in the Arctic. One of the latest springs in history was recorded with the result that many birds of the high Arctic bred only sparingly or not at all. This was certainly true of the birds we observed on Victoria Island where the tundra was almost devoid of song and reproductive activity and many birds were wandering aimlessly about. Perhaps this is a partial explanation for the presence of an adult of this European species in the central Arctic of Canada in the summer.

Color transparencies of this bird have been submitted to the National Museum of Natural Sciences, Ottawa; the National Museum of Natural History, Washington D. C.; and the American Museum of Natural History, New York.

We wish to express our appreciation to Dr. W. Earl Godfrey for his interest in and comments on this observation.

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First Records of Seven Species of Ground Beetles (Coleoptera: Carabidae) from Prince Edward Island

On July 15, 1971, while collecting tiger beetles in Holland Cove Beach, Prince Edward Island, I incidentally took sixteen ground beetles from leaf litter in a nearby spruce forest. The small sample comprised nine fairly well known carabid species. I was therefore surprised to learn, through a literature survey, that seven of the collected species had not been previously recorded from Prince Edward Island. The absence of Island distribution records indicates that carabid beetles have not been carefully sought there for most of the nine collected species are widespread in eastern Canada and the United States and thus one would expect to find them on Prince Edward Island. Further the preferred habitat of these species, mixed spruce stands, is abundant on the Island, and specimens seem to be plentiful and easy to collect. The species and their general distributions are listed below. For each species there is cited, in parentheses, a reference in which the locality records defining the distribution are given in greater detail.

Bembidion properans Stephens (1 male). Distribution: Nova Scotia; widely distributed in Eurasia (Lindroth p. 256, 1963).

Pterostichus adstrictus Eschscholtz (3 females, 2 males). Distribution. Circumpolar and transamerican (Lindroth p. 486-487, 1966).

Pterostichus pensylvanicus Leconte (1 male). Distribution: transamerican but apparently not quite reaching the Pacific coast (Lindroth p. 487, 1966).

Pterostichus melanarius Illiger (1 female, 1 male). Distribution: introduced from Europe both on the Atlantic and the Pacific coast, and rapidly spreading (Lindroth p. 492, 1966).

Synuchus impunctatus Say (1 male). Distribution: mainly eastern but transamerican in Canada (Lindroth p. 551, 1966).

Agonum retractum Leconte (1 female). Distribution: transamerican but very local (notably in the prairie provinces) (Lindroth p. 576-577, 1966).

Amara avida Say (1 female). Distribution: almost transamerican but not reaching the Pacific coast (Lindroth p. 689, 1968).

Literature Cited

Lindroth, C. H. 1963. The ground beetles of Canada and Alaska. 3. Opuscula Entomogica, Supplement 24 (Lund): 201-408.

Lindroth, C. H. 1966. The ground beetles of Canada and Alaska. 3. Opuscula Entomologica, Supplement 29 (Lund): 409-648.

Lindroth, C. H. 1968. The ground beetles of Canada and Alaska. 5. Opuscula Entomologica, Supplement 31 (Lund): 649-944.

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A New Record for *Sonchus uliginosus* Bieb. from Interior Alaska

The Perennial Sowthistle, *Sonchus uliginosus* Bieb. (= *S. arvensis* L. var. *glabrescens* Guenth., Grab., and Wimm.), is a common introduced weed in temperate North America, whose previously reported northwestern range extended to Great Slave Lake area, Mackenzie District Northwest Territories (Thieret, Sida I, 1963, p. 169). The species is similar to *S. arvensis,* but differs in having less pubescence and a lack of glandular hispid hairs on the involucrum and pedicels, and in being a tetraploid (2 n = 36) not a hexaploid (2 n = 54).

Hultén (Flora of Alaska and Neighboring Territories, 1968, p. 950) cites *Sonchus arvensis* in the Northwest Territories from the Great Slave Lake area, and in Alaska only from the Pacific coast localities of Hyder and Skagway in southeastern Alaska and from Northern Kodiak Island. There seems little doubt that Hultén was referring to *S. arvensis* not *S. uliginosus* as he stresses the presence of yellow glandular hairs in his key to species. Anderson (Proceedings of the Iowa Academy of Science, 25, 1918, p. 449) reported *S. arvensis* also from Juneau in southeastern Alaska.

Recently Mrs. Pat Rutledge has found *Sonchus uliginosus* to be apparently well-established on open, well-drained meadow flats south of the University Hill at College, 3 miles west of Fairbanks, Alaska. This represents the first report of the species from Alaska and the most northernly report for the species in North America. Long distance dispersal effected inadvertently by human activities probably accounts for its introduction. A specimen collected from the above site (*Rutledge, 3 July 1972*) is preserved in the Fraser Herbarium, University of Saskatchewan, Saskatoon (SASK).

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Trichostema dichotomum L. (Labiatae) New to Canada

The discovery of *Trichostema dichotomum* in Norfolk County in the southernmost part of Ontario, adds another species to the Canadian flora. The species was discovered in September 1971 on sandy ground in an immature coniferous plantation near the main highway through the St. Williams Department of Lands & Forests plantations (Conc. 1, lot 12, Charlotteville Twp., Norfolk Co.). The area was revisited in early August 1972 and examined more extensively for this species, which is apparently restricted to a few acres of open plantation on bare sandy ground partially stabilized by lichens and mosses. Here the individual plants are widely scattered and nowhere abundant. The species appears to be well established and completely at home in this habitat, but it is not clear whether this represents the northern limit of its natural area of distribution or an accidental introduction into the area.

Earlier reports of the existence of *Trichostema dichotomum* in Canada are to be found in the literature. Drummond (1868) accepts the species as occurring in Canada "on the authority of Michaux or Pursh" but without any indication of locality, and this record remains unsubstantiated. Rouleau (1964) mentions this species as being adventive in Quebec-apparently on the basis of a specimen in the Marie Victorin Herbarium at the University of Montreal-Cleonique 12076 which bears on the label "Environs de la Prairie (île à Paquette) compte de La Prairie, Quebec". However, Dr. Boivin informs us that he considers this specimen to be an "erreur d'etionette" and has annotated it accordingly. There is another collection-Cleonique 2679 (in the same herbarium) from Maine and Dr. Boivin considers the La Prairie specimen to be a duplicate of this which has been incorrectly labelled. Certainly there are very close resemblances between these two sheets and Dr. Boivin's conclusions appear to be justi-

fied. The species is also included in a list of plants of the Kingston region (Beschel et al. 1970) but the record is based on specimens from the New York side of the St. Lawrence. The species is not included either in Soper's (1949) list of the Vascular Plants of Southern Ontario or in the more recent accounts of the flora of Norfolk County (Landon 1960 and Cruise 1969) or in Boivin's Enumeration of the plants of Canada (1966). Nor does it appear in recent floras for other regions of Canada. Hence the present record is apparently the first authenticated report of the existence of *Trichostema dichotomum* in Canada.

Trichostema dichotomum flowers late in the year; it was only in bud in early August. It is an annual species of dry open, usually sandy places, and its distribution in the United States extends northwards to the shores of the Great Lakes and the St. Lawrence. Hence its discovery in an area such as that in Norfolk County is not unexpected. The species extends south and west to Florida, Texas and Michigan.

This record from Norfolk County is supported by the following voucher specimens in the University of Waterloo herbarium: Morton and Venn s.n. and Montgomery 3719.

Literature Cited

Beschel, R. E., A. E. Gorwood, R. Hainault, I. D. Macdonald, S. P. Van der Kloet, C. H. Zavitz. 1970. List of the Vascular Plants of the Kingston Region. Fowler Herbarium, Queen's University, Kingston, Ontario. 92 p.

Boivin, B. 1966. Enumeration des plantes du Canada. Naturaliste Canadien 93(6): 989-1063.

Cruise, J. E. 1969. A floristic study of Norfolk County, Ontario. Transactions of the Royal Canadian Institute 35(72): 3-116.

Drummond, A. T. 1868. Some statistical features of the flora of Ontario and Quebec. Canadian Naturalist and Geologist, n.s. III: 433.

Landon, M. 1960. Vascular plants of Norfolk County, Ontario. The Big Creek Region Conservation Authority, Simcoe, Ontario. 66 p.

Rouleau, E. 1964. Flore Laurentienne by Marie-Victorian ed. 2. University of Montreal Press.

Soper, J. H. 1949. The Vascular Plants of Southern Ontario. Department of Botany, University of Toronto and Federation of Ontario Naturalists, Toronto. 95 p.

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Nesting of the Black Swift at Johnston's Canyon, Alberta

There are few published observations of the nesting of the Black Swift (*Cypseloides niger*) in Canada. In fact the only published records of nesting in Canada refer to nestings at Clinton and Vernon, British Columbia (Grant, 1966) and an old record for Johnston's Canyon, Alberta (Bent, 1964).

In late September of 1965 the author visited Johnston's Canyon and noticed several swift-like nests at two spots in the canyon. The canyon was revisited by the author and Allen Shoults on June 30 and July 1, 1966. On June 30 a few birds were sitting on nests but those that could be examined were empty. On the morning of July 1 the three nests that could be looked into each contained one egg. On July 1, 1967 the canyon was visited by the author, Jack Shier, and Allen Shoults. Again several swifts were seen sitting on nests which proved to contain their characteristic complement of one egg each. The author and Harold Pinel checked the canyon in mid-July of 1970 and again several swifts were found sitting on nests. The author visited the canyon on July 29, 1972 and noted four nests with adults sitting on them, a considerable drop in numbers from previous years.

Although the above observations were quite casual and informal the following statements can be made. At least about half a dozen swifts regularly breed at Johnston's Canyon. This is an exceedingly conservative estimate since nests of this species are notoriously difficult to find and most of the canyon was not thoroughly checked due to the difficult terrain.

Laying of eggs occurs in the last few days of June and the first few days of July. This cor-

relates remarkably well with the time of egg laying in as southerly a latitude as California.

Although Chapman (*in* Bent, 1964) spoke of considerable mud being used in nest construction, the nests I observed were constructed entirely of plant material, especially mosses. In addition, all nests exposed to gusts of spray were surrounded by very noticeable green algal growth. The one nest that was not subject to gusts of spray had below it lichen growth (either *Xanthoria elegans* or a *Caloplaca* sp.).

Knorr (1961) listed the following characteristics of Black Swift nesting sites in Colorado: near water, usually falls and within reach of the spray; above surrounding terrain so that birds leaving nests are at feeding height; inaccessibility; darkness; and unobstructed flyways to and from the nesting sites. The nesting areas at Johnston's Canyon and the positions of the individual nests conform well with these characteristics.

Perhaps the most interesting feature of the Johnston's Canyon swift nests is that they are along a major, well used nature trail and can be seen by anyone using the trail. Yet, since the original discovery of nesting swifts here in 1919, no one has reported the nesting of this species here.

Literature Cited

Bent, A. C. 1964. Life Histories of North American Cuckoos, Goatsuckers, Hummingbirds and Their Allies. Dover Publications, New York. (Reprint of United States National Museum Bulletin 176. 1940.)

Grant, J. 1966. A Black Swift Nest in British Columbia. The Canadian Field Naturalist 80: 60-61.

Knorr, O. A. 1961. The Geographical and Ecological Distribution of the Black Swift in Colorado. The Wilson Bulletin 73: 155-170.

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The Lichen *Cetraria idahoensis* Esslinger from Canada

Abstract. The lichen *Cetraria idahoensis* Esslinger is reported for the first time from Canada. The report is based on four collections from the Nelson Range of the Selkirk Mountains in British Columbia.

Esslinger (1971) recently described a new lichen species which he called *Cetraria idahoensis*. The species is usually attached to the substrate only near the center, similar to the common genus *Platismatia* W. Culberson and C. Culberson, but is sometimes loosely appressed. The upper surface is ashy-gray and dotted with numerous black pycnidia; the lobes are rounded to sublinear and truncate; and the undersurface is erhizinate. Apothecia are usually very abundant, except in the loosely appressed specimens. Material found at elevations above 4,000 feet is of the latter form. The lichen superficially resembles the common *Platismatia* (formerly *Cetraria*) *glauca* (L.) W. Culberson and C. Culberson except for the lack of soredia and isidia, the usually abundant apothecia and pycnidia, and its more gray color.

The previously known distribution of the species included only the states of Idaho, Montana, Oregon, and Washington (Esslinger, 1971). While conducting research on caribou range in June 1972, I made four collections of the species in the Nelson Range of the Selkirk Mountains in British Columbia; these collections represent the first report of the species from Canada.

Two collections, both appressed and without apothecia, were made in the *Abies lasiocarpa* — *Menziesia ferruginea* habitat type (Daubenmire and Daubenmire, 1968) at an altitude of approximately 5,000 feet. The other two collections are from an area, at an elevation of 2,900 feet, which lies between an unlogged stand of *Thuja plicata* and a cutover area now populated with predominantly *Larix occidentalis* and a scattering of *Pinus monticola*.

Thin-layer chromatography, using the three-solution method described by Culberson and Kristinsson (1970), confirmed the presence of atranorin and endocrocin in sample numbers

L2000 and L2092. Sample numbers L2088 and L2090 were not analyzed because only a few small thalli were collected, but the material compares well morphologically with paratype material in the Schroeder Herbarium (Esslinger, 1971).

One packet of all collections cited is in the Schroeder Herbarium and duplicates have been deposited as indicated.

Specimens seen: British Columbia. Near Blazed Creek-Summit Creek confluence at 2,900 feet elevation, on branches of *Pinus monticola* trees, *Schroeder L2000* (CANL, COLO, H); (Same locality) on branches of *Larix occidentalis* trees, *Schroeder L2092* (Herb. D. E. Anderegg, UAC, UBC); Approximately 3 miles NE of Bridal Lake (Kootenay Pass) at 5,000 feet elevation, on dead *Picea engelmannii* trees, *Schroeder L2088;* (Same locality) on dead *Abies lasiocarpa* trees, *Schroeder L2090.*

Literature Cited

Culberson, C. F. and **H. Kristinsson.** 1970. A standardized method for the identification of lichen products. Journal of Chromatography 46: 85-93.

Daubenmire, R. and **J. B. Daubenmire.** 1968. Forest vegetation of eastern Washington and northern Idaho. Publications of the Washington Agricultural Experiment Station, Pullman. 104 p.

Esslinger, T. L. 1971. *Cetraria idahoensis,* a new species of lichen endemic to western North America. Bryologist 74: 364-369.

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Chestnut-collared Longspur in British Columbia

This note is to document the observation of a Chestnut-collared Longspur, *Calcarius ornatus* (Townsend), on a bare, offshore rock in British Columbia coastal waters. The specific location is the Faber Islets, Barkley Sound, west coast of Vancouver Island (48°53′N, 125°18′W) and the date of the sighting is 18 June 1972.

Though I had not previously seen this species, I immediately recognized the bird as a longspur, and its adult male plumage featuring the chestnut collar, the black and white head with black eyeline, and jet black breast and belly left little chance for misidentification. I obtained three black and white photographs and these are now on file (Number 224) in the University of British Columbia Vertebrate Museum (see Campbell and Stirling, 1971). Museum curator, R. W. Campbell, confirmed my identification from these photographs.

Swarth (1924) collected an adult female near Hazleton in north-central British Columbia on 8 July 1921, and Munro and Cowan (1947) report a specimen record (29 May 1930) from Newgate, in the southeastern corner of the province. The latter area is just over the mountains from the western edge of the bird's normal range in the southern prairies. These are the only previous accounts of the Chestnut-collared Longspur in British Columbia. The present record, the first in over 40 years and the first from the coast, certainly does not change its status as 'casual' (Godfrey, 1966) in this province, although it extends the range as far west as it is likely to go.

Literature Cited

Campbell, R. W. and **D. Stirling.** 1971. A photoduplicate file for British Columbia vertebrate records. Syesis 4: 217-222.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada, Bulletin No. 203. 428 p.

Munro, J. A. and **I. McT. Cowan.** 1947. A review of the bird fauna of British Columbia. B.C. Provincial Museum Special Publication No. 2. 285 p.

Swarth, H. S. 1924. Birds and mammals of the Skeena River region of northern British Columbia. University of California Publications in Zoology 24: 315-394.

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New Plant Records in Waterton Lakes National Park, Alberta

Abstract. Forty-six species of vascular plants are reported as new to Waterton Lakes National Park, Alberta. Ten of these species represent new provincial records.

Introduction

Waterton Lakes National Park, situated in the south-western corner of Alberta, is a region of unusual scenic and botanical interest. The extensive glaciation of the Rocky Mountains here has left a richly varied topography providing for a wealth of habitats. Many of the plants native to the Park occur nowhere else in Alberta, as the Pacific Yew (*Taxus brevifolia* Nutt.), the rare white Ladyslipper (*Cypripedium montanum* Dougl.), and the Mock Orange (*Philadelphus lewisii* Pursh). A catalogue of the plants of the Park was published some years ago by Breitung (1957), who also included a general sketch of its topography and vegetation.

As a result of intensive collecting of vascular plants in the Park since 1968, a considerable number of new records has accumulated; these are presented herewith. The work has been carried out with financial support from both the National Research Council of Canada and the Department of Indian Affairs and Northern Development. The major set of herbarium material has been deposited at the University of Lethbridge, with additional sets at Waterton Lakes National Park Headquarters and the National Museum of Natural Sciences in Ottawa.

For convenience of reference the list is organized alphabetically. Species which carry an asterisk (*) represent new records not only for Waterton Lakes but also for the Province of Alberta. It may be pointed out that the new additions and Breitung's (1957) catalogue together add up to some 55% of the number of species recorded for the entire Province (Moss, 1959). This percentage goes far in expressing the floral wealth of the south-western corner of Alberta when one considers that the Park's area amounts to less than 0.1% of the Province. The main reasons for this unusual concentration of species are perhaps to be found in the fortunate inclusion of a segment of prairie vegetation in a predominantly mountainous park, and in the high precipitation (Duffie and Nemeth, 1969).

It is a pleasure to acknowledge assistance extended to me by the following colleagues: J. H. Beaman (*Townsendia*); N. H. Holmgren (*Castilleja*); N. A. Harriman (*Carex backii*); A. R. Kruckeberg (*Silene*); H. J. Scoggan (*Carex paysonis*); T. M. C. Taylor (*Cheilanthes, Lycopodium,* and *Woodsia*); R. K. Vickery (*Mimulus*); and W. H. Wagner (*Botrychium*).

Species New to Waterton Lakes National Park

BORAGINACEAE	
**Myosotis micrantha* Pall. ex Lehm.	
Lonesome Lake	Nagy & Gadd 3268
Cameron Bay	Nagy & Dobbins 4228
Linnet Lake	Kuijt & Dobbins 4235
CARYOPHYLLACEAE	
Cerastium nutans Raf.	
East end, Lakeview Ridge	Blais & Nagy 1472, 1493
Dardanelles	Nagy & Yamashita 3447
**Sagina procumbens* L.	
West Side, Bertha Lake	Kuijt & Blais 2205
**Silene douglasii* Hook.	
Crypt Lake	Kuijt et al. 4404
**Stellaria nitens* Nuttall	
Roadside, Blakiston Creek bridge	Kuijt & Dobbins 4238
COMPOSITAE	
Centaurea maculosa Lam.	
Roadside south of main gate	Kuijt 3138
Additionally from outside the Park:	
Frank	Kuijt 3094
13 mi. west of Bassano	Kuijt 4071
Erigeron pallens Cronq.	
Carthew Mt.	Armstrong & Nagy 5096
**Townsendia condensata* D. C. Eaton	
Ridge south of Horseshoe Basin	Kuijt, Gadd, & Nagy 3533
Note: This collection was recently cited by Packer & Dumais (1972); the species had previously not been reported from Canada. An additional record is known from outside the Park:	
Mt. Whistler, Castle River area	Kuijt & Gadd 209
CRUCIFERAE	
Barbarea vulgaris R. Br.	
Belly River	Blais & Nagy 1864
Cardston Gate	Nagy 3760
Draba densifolia Nutt.	
South-east ridge, Mt. Glendowan	Kuijt, Nagy, & Gadd 4253
**Draba verna* L.	
Cameron Bay	Kuijt, Nagy, & Dobbins 4229
CYPERACEAE	
Carex backii Boott	
East end, Lakeview Ridge	Blais & Nagy 1538
**Carex paysonis* Clokey	
New Interpretive Building area	Blais & Nagy 1426

CUPRESSACEAE
Juniperus scopulorum Sarg. × *J. horizontalis* Moench
Blakiston Falls — Nagy & Blais 379
Bertha Lake — Blais, Nagy, & Kuijt 407
Above Crypt Landing — Kuijt et al. 4461
Lakeshore trail — Armstrong & Nagy 4852
Trail to Lone Lake — Kuijt, Armstrong, & Nagy 4951

ERICACEAE
Hypopitys monotropa Crantz (*Monotropa hypopitys* L.)
Sofa Creek Beaver Ponds — Armstrong & Nagy 4536
Trail to Lone Lake — Kuijt, Armstrong, & Nagy 4886, 4950
Rhododendron albiflorum Hook.
Upper Twin Lake — Kuijt & Blais 2918
Lost Lake, south-west shore — Sharp s.n.
Vaccinium myrtillus L.
Lower Twin Lake — Blais & Nagy 1767
Trail to Rowe Lakes — Armstrong & Nagy 4713
Mt. Vimy — Nagy 4789

FUMARIACEAE
Corydalis aurea Willd.
Bertha Bay Viewpoint — Nagy & Blais 597
East of Red Rock Canyon — Kuijt, Nagy, & Gadd 4290

HYDROPHYLLACEAE
Phacelia linearis (Pursh) Holz
Horse trail, Information Center — Kuijt & Nagy 4293

JUNCACEAE
Juncus triglumis L. var. *albescens* Lange
Bog, east side of Sofa Mt. — Kuijt, Armstrong, & Nagy 5137

LABIATAE
**Mentha spicata* L.
Bridge, Red Rock Canyon — Kuijt 3110

LEGUMINOSAE
Astragalus drummondii Dougl.
New Interpretive Building area — Blais & Nagy 286
Bertha Bay Viewpoint — Nagy 595

LEMNACEAE
Lemna minor L.
Beaver Ponds, Pincher Creek gate — Kuijt, Gadd, & Nagy 3104

LILIACEAE
Fritillaria pudica (Pursh) Spreng.
Mt. Glendowan, southeast spur — Kuijt, Nagy, & Gadd 4272

LYCOPODIACEAE
Lycopodium sitchense Rupr.
Castle Divide — Armstrong & Nagy 5066

MORACEAE
Humulus lupulus L.
Bridge, Red Rock Canyon — Kuijt 3108

ONAGRACEAE
Oenothera flava (A. Nels.) Garrett
Indian Springs Pond — Blais 1683

OPHIOGLOSSACEAE
Botrychium boreale (Fr.) Milde
Trail to Twin Lakes — Kuijt & Blais 1271
Botrychium dusenii (Christ) Alston
Chief Mt. road — Kuijt, Blais, & Nagy 1618
Botrychium simplex E. Hitchc.
West of Bertha Lake — Blais, Nagy, & Kuijt 394
Twin Lakes trail — Blais & Nagy 2321, 2340*b*
North Belly River — Nagy & Armstrong 4032
Mt. Glendowan, south-east spur — Kuijt, Nagy, & Gadd 4271

ORCHIDACEAE
Listera convallarioides (Sw.) Nutt.
Lakeshore trail — Armstrong & Nagy 4871

POLYPODIACEAE
**Cheilanthes gracillima* D. C. Eaton
Bertha Lake — Blais, Nagy, & Kuijt 403
Woodsia oregana D. C. Eaton
Red Rock Canyon area — Blais & Nagy 1307
Coppermine Creek — Nagy & Gadd 3219
Bertha Lake — Gadd & Nagy 3566

PORTULACACEAE
Montia linearis (Dougl.) Greene
Red Rock Canyon area — Blais & Nagy 1281
Lonesome Lake — Nagy & Gadd 3270
Lost Lake — Kuijt, Nagy, & Armstrong 4067

POTAMOGETONACEAE
Potamogeton alpinus Balbis
Marquis Hole — Armstrong & Nagy 3985
Crooked Creek Pond — Armstrong & Nagy 5075

RANUNCULACEAE
Ranunculus glaberrimus Hook. var. *ellipticus* Greene
West of Belly River Warden Station — Blais, Nagy, & Gadd 87
Mt. Rowe — Nagy & Blais 958
Coppermine Creek — Nagy & Gadd 3239
Bertha Lake — Gadd & Nagy 3563
Mt. Glendowan, south-east spur — Kuijt, Nagy, & Gadd 4280
Ranunculus pedatifidus J. E. Smith
East end, Lakeview Ridge — Blais & Nagy 1515
Mt. Galloway, north-east slope — Kuijt, Gadd, & Nagy 3371
Dardanelles near Knights Lake — Nagy & Yamashita 3474*b*

SAXIFRAGACEAE
Lithophragma parviflorum (Hook.) Nutt.
Bellevue Hill — Nagy & Blais 622
Mt. Rowe — Nagy & Blais 943*b*
Lonesome Lake — Nagy & Gadd 3262
Above Blakiston Falls — Nagy & Gadd 3332
Saxifraga debilis Engelm. ex Gray (*S. rivularis* L.)
Lower Twin Lake — Blais & Nagy 1759
Upper Rowe Lakes trail — Armstrong & Nagy 4656*b*
Lone Lake — Kuijt, Armstrong, & Nagy 4922
Saxifraga odontoloma Piper (*S. arguta* auctt., not D. Don)
Lower Twin Lake — Kuijt & Blais 2942
Red Rock Canyon area — Armstrong & Nagy 3945*b*
Rowe Lakes trail — Armstrong & Nagy 4672
Mt. Vimy — Nagy 4777*b*
Castle Divide — Armstrong & Nagy 5061

SCROPHULARIACEAE
Castilleja sulphurea Rydb.
Vimy trail — Blais & Nagy 1207
East end, Lakeview Ridge — Blais & Nagy 1447, 1531
Chief Mt. road — Kuijt, Blais, & Nagy 1609

Oil Basin Nagy 2569
Linaria dalmatica (L.) Mill.
Golf course entrance Nagy 3697
Mimulus membranaceus A. Nels.
(*M. floribundus* Dougl. var. *membranaceus* (A. Nelson) Grant
Red Rock Canyon Kuijt & Gadd 4390
SPARGANIACEAE
Sparganium minimum Fries
Maskinonge Lake Armstrong & Nagy 4341
UMBELLIFERAE
Lomatium macrocarpum (Nutt.) Coult. & Rose
Bear's Hump Kuijt & Nagy 4295
Mt. Glendowan, south-east spur Kuijt, Nagy & Gadd 4285
Sofa Mt. Kuijt & Gadd 4375
VISCACEAE (Loranthaceae, s.l.)
Arceuthobium americanum Nutt. ex Engelm.
(see also Baranyay, 1970)
South-east corner of Park Kuijt 4131, 4134

Literature Cited

Baranyay, J. A. 1970. Lodgepole pine dwarf mistletoe in Alberta. Department of Fisheries and Forestry, Canadian Forest Service, Publication No. 1286.

Breitung, A. J. 1957. Plants of Waterton Lakes National Park, Alberta. Canadian Field-Naturalist 71: 39-71.

Duffie, P. J. B., and **Z. Nemeth.** 1969. A forest land capability classification for the east slopes area, Alberta. Department of Fisheries and Forestry, Forestry Branch, Forest Research Laboratory, Information Report A-X-20.

Moss, E. H. 1959. Flora of Alberta. University of Toronto Press, Toronto.

Packer, J. G., and **M. G. Dumais.** 1972. Additions to the flora of Alberta. Canadian Field-Naturalist 86: 269-274.

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The Granivorous Habits of Shrews

For several summers my brother Norman and I studied the daily activities of various local insects and found that they hibernated from an inch or so to as much as six feet below the surface of the ground. Species which hibernated at the lowest levels began their downward migration in early September and reappeared in late April or early May. Those which hibernated just below the surface or under decaying vegetation remained active for a longer period in the autumn and appeared again in April. It was interesting to note that the feeding habits of local shrews, probably mostly the masked shrew, *Sorex cinereus Kerr* and the short-tailed shrew, *Blarina brevicauda* (Say) changed seasonally from insectivorous to granivorous along with these shifts in insect populations.

We found that shrews feed almost entirely on seeds during the winter. Their diet begins to change when the first spring thaw releases insects that hibernated close to the surface. They become almost exclusively insectivorous when the days become warmer and insects from the lower levels reappear. During the summer, cutworms, grasshoppers, and caterpillars are the most important items in their diet and are a source of moisture as well as food during this period when free water is scarce in the prairies. The return to a granivorous habit starts early in September and is likely complete by the end of the month when even the most active beetles retire for the winter.

These general observations are supported by analyses of stomach contents from shrews caught during the winter months in various localities. All showed a complete diet of seeds. Animal food is still preferred at this time, however, for caged shrews chose bits of flesh and field mice before other foods. Excess meat was occasionally dragged to a corner of the cage, but was never covered. Among seeds, the shrews showed a preference for oats and wheat, but excess of these was not stored. There was no evidence of seed storage for winter reserves.

A good friend kindly sent me two specimens of *Microsorex* from the jack pine forest some 60 miles east of Winnipeg. Their stomach contents were entirely of jack pine seeds. A single *Blarina* was taken in a grain stack. Its stomach contents were entirely of wheat. Two specimens of *Sorex* were also taken, one in a bin of rye grass and one

in a bin of brome grass; their stomachs were full of these seeds. Persistence of the carnivorous habit in winter shrews was illustrated by two incidents: many tracks and tunnels of shrews in the snow were seen around the carcass of a horse by the roadside; a bush rabbit skeleton found beneath the snow was stripped clean of flesh by one or two shrews. Apparently the diet of these animals is related entirely to the kind of food available.

STUART CRIDDLE

Editor's Note: This note was submitted for publication in The Canadian Field-Naturalist before the death of Dr. Criddle. We are pleased to publish it in the same issue as his biography. Dr. Criddle's observations were made at Aweme, Manitoba.

Purple Coneflower, *Echinacea purpurea,* in Ontario[1]

On July 19, 1952, Lorne E. James gathered specimens of *Echinacea purpurea* (L.) Moench ½ mile north of St. Thomas in Elgin County, *James 1866* (DAO, TRT). A more exact locality was given by Stewart and James (1969): St. Thomas, Kettle River Valley, one-half mile downstream from Waterworks Park. The plant was recorded as sparse in clay soil of dry grassland, but this situation might better be termed a waste area because the area was originally covered by a very dense deciduous forest and was not natural prairie.

The above collection was the basis for Boivin's report (1966) of this species for Southern Ontario. This report was in fact the first published record of the occurrence of *Echinacea purpurea* growing outside of cultivation in Canada, although it was not noted as such.

A second collection was made recently in the vicinity of Ottawa. Data are as follows: Carleton Co., March Twp., Conc. 4, Lot 18, about 1 mile north of Harwood Plains, waste ground along roadside, remote from any building or garden, rare, *Adams & Kemp 5,* 24 Aug. 1972 (DAO).

The natural distribution of *E. purpurea* is given by Fernald in the eighth edition of Gray's Manual as "Dry open woods and prairies, Ga. to La., n. to Va., O., Mich., Ill. and Ia.; casually adv. north-eastw." The long purple ligules surrounding the dark brownish disc florets in the flower head are quite showy, thus making the plant of interest to gardeners. It has been grown in the test plots at the Central Experimental Farm at Ottawa, and undoubtedly by horticulturists and gardeners elsewhere in the province. It will likely be found again as a casual escape in the province and could possibly become permanently established in warmer and drier situations in Southern Ontario.

Echinacea purpurea can readily be distinguished from *E. pallida,* which is also adventive in southern Ontario, and *E. angustifolia,* which is a native species in southern Manitoba and Saskatchewan, by its broadly to narrowly ovate leaves which are rounded at the base and usually bear coarse teeth along the margins rather than lanceolate to lance-linear leaves, attenuate to the base with entire margins.

Literature Cited

Boivin, B. 1966. Enumération des plantes du Canada IV. Naturaliste Canadien 93: 989-1063.

Stewart, W. G. and **L. E. James.** 1969. A Guide to the Flora of Elgin County, Ontario. Catfish Creek Conservation Authority 118 pp.

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[1]Contribution No. 928 from the Plant Research Institute, Canada Department of Agriculture, Ottawa.

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STUART CRIDDLE, 1877-1971

CHARLES D. BIRD[1]

Canada lost an outstanding field-naturalist in October 1971 with the passing away, at the age of 94, of Stuart Criddle. The author of many articles on small mammals, and proficient in many other areas, Stuart was well known and respected by layman and scientist alike.

Stuart was born at Addlestone, Surrey on December 4, 1877. His Scottish mother, Alice (Nicol), was one of the first woman scholars of Cambridge University where she was associated with Thomas Huxley and other noted scientists. His father, Percy, a wine merchant of English descent, attended university at Heidelberg and was educated in music, law, and medicine (Scott 1970, 1971, 1972).

Stuart came to Canada at the age of four with his parents, brothers Evelyn and Norman, and sister Beatrice in August 1882. They arrived at Brandon one year after the Canadian Pacific Railway had reached that point. His father came to Manitoba with little or no knowledge of farming and, after searching for a week or so, chose as a homestead 160 acres of Aspen Parkland with light sandy soil. The land looked attractive to him because it needed little clearing and was easily ploughed. The area, 20 miles southeast of Brandon and 5 miles north of Treesbank, was later described by R. D. Bird (1927). Though Percy was not penniless upon arrival, the funds needed to set up the establishment and keep the family in necessities soon depleted his resources, and they knew some hard times before the farm began to show some returns for their labors. Pioneer life was rugged, and to the uninitiated imposed hardships and exertion almost beyond description. His mother, a very strong and active woman who had probably never seen a team of oxen before in her life, had to suddenly become a driver. As they did not initially have a horse, his father had to walk to Brandon for provisions, a hike of over 40 miles round-trip that he did in one day by leaving about 3 am and getting back late in the evening. Three other daughters and one son were born after his parents arrived in Canada: Maida in 1884, Julia in 1887, Talbot in 1890, and Alma in 1893.

In later life, Stuart was fond of reminiscing about how, on their arrival, Brandon was white with tents for three or four hundred yards and about how different the country around their farm was from what it looks today. For a number of years prior to their arrival there had been widespread fires, and years of heavy rainfall that had resulted in a raising of the water table and the formation of many ponds. In an interview with Mr. Gerald Malaher, on March 23, 1971, he stated "Everything had been burned off, all except in the low places, years before we came, and from Bonfire Hill as we called it, because we used to light a fire when the Governor was coming back from Brandon with the oxen, we could see Brandon quite plainly, there were no trees or anything . . . and there was a nice pond, about 3 feet deep, just down below the hill, the road goes through it now. That was our duck pond where my father had a blind put up so that he could stalk behind it and pot a duck now and then." He also commented that, even though they were in a poor agricultural area, "the whole area had been taken up" in the homesteading rush and that they had numerous neighbors nearby. Indians came down nearly every spring to purchase young horses. Stuart commented that they were friendly, and that once or twice "they'd fetch a good chunk of venison for sugar and tea and things like that." Sternwheelers carried freight on the Assiniboine between Winnipeg and Currie's Landing for a few years after the railroad had arrived and their whistles could occasionally be heard from the farm.

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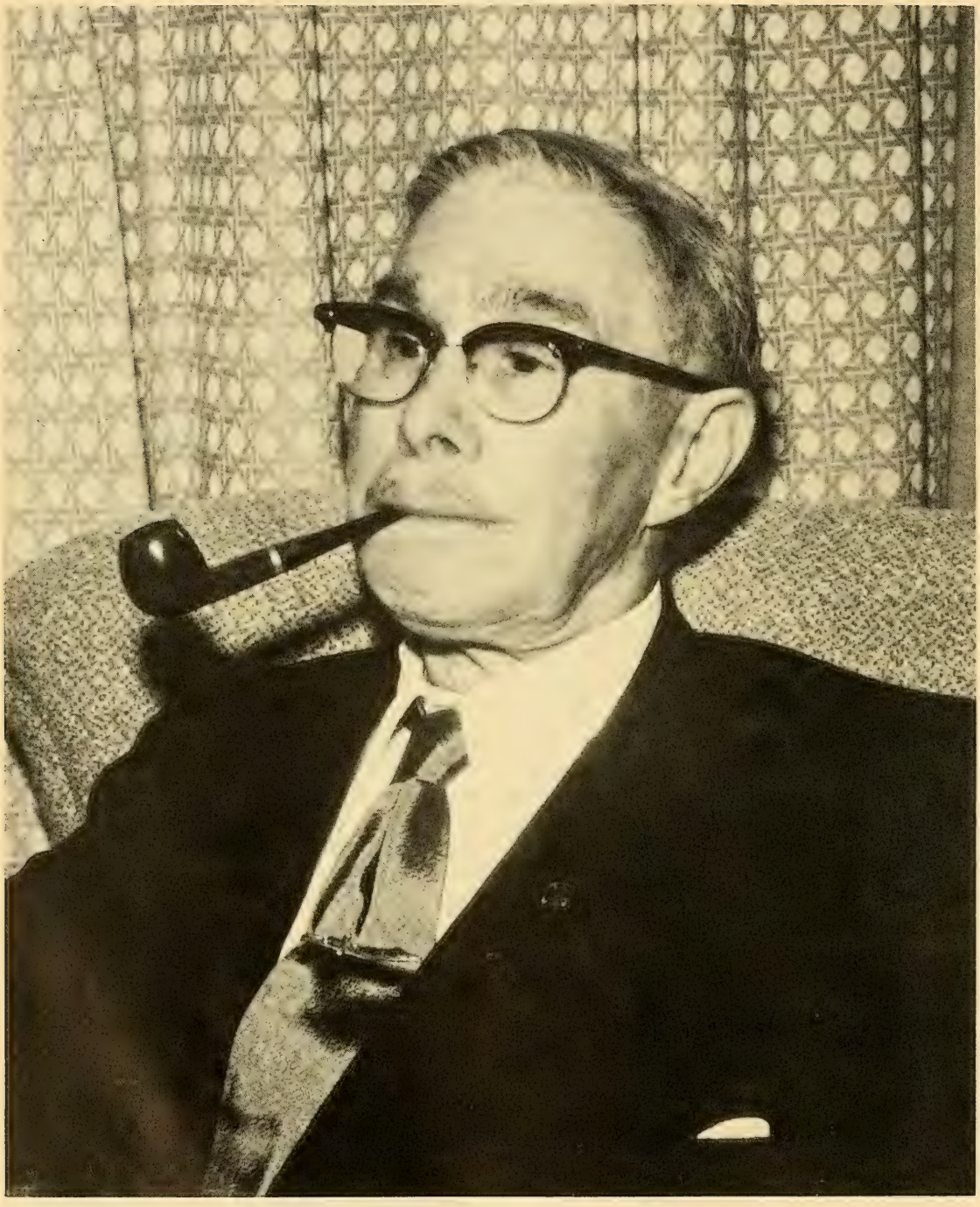

STUART CRIDDLE

Photo by R. D. Bird, March 1962.

Stuart commented that, on their arrival, only Mule Deer frequented the area. It was not until the late 1880's that the first White-tailed Deer, that eventually replaced the Mule Deer, arrived. He also talked about a group of 6 to 7 Pronghorn Antelope that wintered in the Spruce Woods about 1907; none have been seen in the area since that time. Fishing in the Assiniboine had been good for Goldeye, Pike, and Pickerel. Sturgeon were often seen and on one occasion Stuart caught a large one of somewhere between 40 and 70 pounds but he lost it when it flipped out of the boat.

In 1884 a Post Office called Aweme was established three quarters of a mile west of the Criddle house, across the road from the school. The Post Office operated until 1917, the building later becoming the home of Julia and Frank Gowan. The name Aweme became well known in later years as it was cited in many of the scientific publications of the Criddle brothers and it appeared as the locality mentioned for many specimens now residing in various museums.

Though Percy was a trustee of the first school district established at Aweme, the Criddle brothers and sisters never attended school. Their parents, with their excellent academic background, taught the children at home especially during the winter months. Their mother encouraged Norman and Stuart to become proficient in natural history and Stuart mentioned sitting in a corner and listening while she would give them lessons for a couple of hours or so in the evenings.

The Criddles soon flourished and their farm home became one of the social and cultural centers of southwestern Manitoba and a Mecca for scholars and sportsmen from many parts of the continent. They constructed their own nine-hole golf course, a cricket pitch, and several tennis courts and proved to be excellent sportsmen and of championship material in tournament contests.

Stuart's first publication, coauthored with his brother Norman, appeared in 1913. The topic was the general biology of *Mephitis hudsonicus*, the Broad-striped Skunk, featuring field observations on food habits, behavior, and population numbers. It was the beginning of a long series of papers dealing with the mammals of southern Manitoba.

During the years from 1914 to 1916 Stuart corresponded with Oliver P. Hay of the Carnegie Institute of Washington with respect to remains of fossil bisons which he had discovered 3 miles south of Douglas. The material was eventually found to be of the extinct *Bison occidentalis*. In the 1950's he found additional material that was thought to be much older and of another extinct species.

In World War I, Stuart joined the 79th Infantry, later transferring to the 52nd, of the Canadian Army. He saw action in several major battles, being wounded in the foot at Vimy Ridge in 1917. His prowess as a scout and sniper led to his being awarded several medals and trophies. During his absence, his sister Alma died in 1917, his father on April 17, 1918, and his mother three or four months later.

Stuart married Ruth Watkins of Belmont, Manitoba, on June 4, 1919, and moved from the family home, called "St. Albans" or simply the "big house" which was built in 1906, to his new house nearby, called "Gardenview". Stuart and Ruth had two children, Ann Margaret (Nan) born on January 1, 1922, and Percy N., born on May 27, 1923.

Stuart's brother Norman, who died in 1933, achieved fame as a naturalist, being expert in entomology, ornithology, mammalogy, and botany. He was well known for his discovery of the "Criddle Mixture" of Paris Green and fresh horse manure which became, with the substitution of bran and sawdust for the manure, the standard poison wherever grasshoppers were a problem (Gray 1967). Norman first developed a special interest in entomology after studying the emergence of a *Polyphemus* moth Stuart had found just starting to come out of its chrysalis. Accounts of Norman's life and contributions have been published by Lloyd (1933), Gibson and Crawford (1933), and R. D. Bird (1955, 1963). His sister Maida was recently honored by the Canadian Government for keeping weather records at the farm from 1933 until she left for the coast in 1960.

Weather records had been previously kept by her father and then by her brother Norman. These records cover a longer time span than those from most other areas in western Canada.

Many prominent scientists owe much to the inspiration and training they received at the Criddle farm where they were exposed to information not to be found elsewhere, and to the philosophy of those who lived close to nature. Included in this group were Ralph Bird (C. D. Bird 1972), the widely known researcher and writer about the ecology of the Aspen Parkland (e.g., R. D. Bird 1930, 1961), and J. B. Wallis (R. D. Bird 1958), a school teacher famous for his studies on butterflies (e.g., Wallis 1927) and beetles (e.g., Wallis 1961). Ernest Thompson Seton, who published several volumes dealing with Manitoba mammals (1919, 1929), visited the farm on a number of occasions to gather information and according to Stuart he didn't seem to know nearly as much about mammalogy as the Criddles did. Aldo Leopold referred to the Criddles, in his book *A Sand County Almanac,* as "recognized authorities on everything from local botany to wildlife cycles".

Stuart was a keen observer of animal life and his field notes are a meticulous, week-to-week record of events regarding their welfare, habits, foods and behavior. His records of the arrival and departure times of migratory birds (e.g., S. Criddle and N. Criddle 1917) are among the most extensive and detailed for this area. He also carried out many breeding experiments with lilies, sunflowers, and corn. He belonged to the Lily Society of America and had one of his new varieties of lilies named after him by the Federal Experimental Farm in Brandon.

Though generally speaking a mild man, Stuart's ire was quickly aroused by any abuse of the wildlife regulations. This perhaps arose because his father, in the early days on the farm, was the local Justice of the Peace and Game Warden. Because of his well known interest in conservation, Stuart was appointed an Honorary Game Guardian in the early 1930's, a function he performed most admirably until he moved to Vancouver Island. He was appointed to the Manitoba Game Advisory Committee by the Hon. J. S. McDiarmid and served on it for more than a decade.

In addition to being a keen observer of natural history and a strong believer in wildlife management, Stuart enjoyed hunting big game, upland birds, and waterfowl. R. D. Bird (1939) described a hunt for Woodland Caribou in the Winnipeg River area in 1938 in which both he and Stuart bagged fine trophies. Organized hunts on the farm with an elected "captain", usually Stuart, and a party of a dozen or so hunters were a highlight during the annual deer season. Each bluff and wooded area had its own name, and years of experience had revealed how each should be driven.

He was a Charter Member of the American Society of Mammalogists from its foundation in 1920. He was a Founding Member of the Manitoba Museum Association, served for 25 years on its Executive Council, and was made a Life Member on May 14, 1957. He was also a Life Member of the Wawanesa Branch of the Royal Canadian Legion.

Included among Stuart's hobbies were inlay work and making walking sticks. He made a number of meticulously worked jewel boxes with inlays of various kinds of local and imported woods which featured mother-of-pearl from clams collected locally from the Assiniboine River. The walking sticks that he made in later life were constructed from native wood, especially choke-cherry.

The original homestead quarter section gradually grew in size as neighboring people moved out and the Criddles purchased land to make their holdings more economical. The farm eventually became almost 5000 acres in size. There was a change of emphasis as well, from farming to ranching as they learned how to better utilize the land. Their length of tenancy of the farm, from 1882 to 1960, must be a near record for Manitoba.

Stuart's son, Percy, married Rae Milligan, the daughter of an R.C.M.P. Superintendent on June 3, 1950. In late 1960 they and their six children moved to near Sidney, B.C., with the older members of the family (Martinson 1960). Immediately after their arrival, Percy

started developing an area of wild land, purchased years before, into what is now the beautiful Glen Meadows Golf Course. Stuart married Kathleen Haynes on January 4, 1963, his wife, Ruth, having died on October 8, 1960, shortly before the move to the coast.

Stuart Criddle and part of his mammal collection. Photo taken November 8, 1959 by R. D. Bird.

In 1963 Stuart was made an Honorary Member of *The Ottawa Field-Naturalists' Club* because of his outstanding contributions to Canadian natural history. In 1968, at the age of 91, he achieved the great honor of being awarded an honorary Doctor of Science degree at the first convocation of Brandon University.

Stuart died on October 23, 1971, being survived by his second wife; brother Evelyn, who subsequently passed way on January 23, 1972; brother Talbot; sister Maida; daughter Mrs. Gordon (Nan) Kenyon of Penticton; son Percy; and nine grandchildren. Stuart returned to the true family burying ground among the trees at Aweme where only his immediate relatives lie.

Acknowledgements

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Publications of S. Criddle

Criddle, N. and **S. Criddle.** 1913. The Broad-Striped Skunk (*Mephitis hudsonicus* Rich.). Ottawa Naturalist 27: 46-49.

Criddle, S. and **N. Criddle.** 1917. Horned Larks at Aweme, Manitoba. Ottawa Naturalist 30: 144-148.

Criddle, N., E. Criddle and **S. Criddle.** 1923. The Coyote in Manitoba. Canadian Field-Naturalist 37: 41-45.

Criddle, N. and **S. Criddle.** 1925. Weasels of Southern Manitoba. Canadian Field-Naturalist 39: 142-148.

Criddle, S. 1926. The habits of *Microtus minor* in Manitoba. Journal of Mammalogy 7(3): 193-200.

Criddle, S. 1929. An annotated list of the mammals of Aweme, Manitoba. Canadian Field-Naturalist 43(7): 155-159.

Criddle, S. 1930. The Prairie Pocket Gopher, *Thomomys talpoides rufescens*. Journal of Mammalogy 11(3): 265-280.

Criddle, S. 1932. A few records of mammals from Manitoba. Canadian Field-Naturalist 46(8): 188.

Criddle, S. 1932. The Red-backed Vole (*Clethrionomys gapperi loringi* Bailey) in southern Manitoba. Canadian Field-Naturalist 46(8): 178-181.

Criddle, S. 1937. Snakes from an ant hill. Copeia 1937: 142.

Criddle, S. 1938. A study of the Snowshoe Rabbit. Canadian Field-Naturalist 62: 31-40.

Criddle, S. 1939. The Thirteen-striped Ground Squirrel in Manitoba. Canadian Field-Naturalist 53: 1-6.

Criddle, S. 1943. The Little Northern Chipmunk in Southern Manitoba. Canadian Field-Naturalist 57: 81-86.

Criddle, S. 1947. A nest of the Least Weasel. Canadian Field-Naturalist 61: 69.

Criddle, S. 1947. Timber Wolf den and pups. Canadian Field-Naturalist 61: 115.

Criddle, S. 1947. *Microtus minor* and Prairie Lily. Canadian Field-Naturalist 61: 116.

Criddle, S. 1950. The *Peromyscus maniculatus bairdii* complex in Manitoba. Canadian Field-Naturalist 64: 169-177.

Criddle, S. 1956. Drummond's Vole in Manitoba. Canadian Field-Naturalist 70: 78-84.

Criddle, S. 1959. History of the Cottontail in Manitoba. Canadian Field-Naturalist 73: 177.

Criddle, S. 1973. The Granivorous Habits of Shrews. Canadian Field-Naturalist 87(1): 69-70.

Other Literature Cited

Bird, C. D. 1972. Ralph Durham Bird, 1901-1972. Canadian Field-Naturalist 86(4): 393-399.

Bird, R. D. 1927. A preliminary ecological survey of the district surrounding the Entomological Laboratory at Treesbank, Manitoba. Ecology 7: 207-220.

Bird, R. D. 1930. Biotic communities of the Aspen Parkland of Central Canada. Ecology 11: 356-442.

Bird, R. D. 1939. Manitoba Caribou. Rod and Gun in Canada. 39(8): 6-8, 37.

Bird, R. D. 1955. Norman Criddle, 1875-1933. Newsletter, Entomological Division, Ottawa 33(8): 2-3.

Bird, R. D. 1958. John Brathwaite Wallis, 1877-. Newsletter, Entomological Division, Ottawa 36(5): 2-3.

Bird, R. D. 1961. Ecology of the Aspen Parkland of Western Canada in relation to land use. Canada Department of Agriculture, Research Branch, Publication 1066.

Bird, R. D. 1963. A history of agricultural entomology in Manitoba. Proceedings of the Entomological Society of Manitoba 19: 7-11.

Gibson, A. and **H. G. Crawford.** 1933. Norman Criddle. Canadian Entomologist 65: 193-200.

Gray, J. H. 1967. Men against the desert. Modern Press, Saskatoon.

Hay, O. P. 1924. The Pleistocene of the Middle Region of North America and its vertebrated animals. Carnegie Institution of Washington, Publication No. 322 A.

Leopold, A. 1949. A Sand County Almanac. Oxford University Press, New York.

Lloyd, H. 1933. Norman Criddle 1875-1933. Canadian Field-Naturalist 57: 145-147.

Martinson, Q. H. October 27, 1960. Pioneer Manitoba family moves to British Columbia. The Manitoba Co-Operator, Page 16.

Scott, C. A. September 1970. Norman and Stuart Criddle, Manitoba's Pioneer Naturalists. Zoolog 11: 10-13.

Scott, C. A. 1971. The Criddles of Aweme. Manitoba Conservation Comment, Department of Mines, Resources and Environmental Management, Winnipeg. 6 pp.

Scott, C. A. March 1972. Criddle of Aweme: Naturalist. Water, Woods and Wildlife, No. 11.

Seton, E. T. 1919. Life histories of northern animals; an account of the mammals of Manitoba. 2 Vols. Charles Scribner's Sons, New York.

Seton, E. T. 1929. Lives of game animals. 4 Vols. Doubleday, Doran and Co.; Garden City and New York.

Wallis, J. B. 1927. A colour key to the Manitoba butterflies. Natural History Society of Manitoba. 31 pp.

Wallis, J. B. 1961. The Cicindelidae of Canada. University of Toronto Press, Toronto.

News and Comment

New Honorary Members of The Ottawa Field-Naturalists' Club

On the recommendation of the Membership Committee, the Council of The Ottawa Field-Naturalists' Club, at its meeting of November 23, 1972, unanimously approved conferring Honorary Membership on five longtime Club Members. These members were chosen because they have made outstanding contributions to Canadian natural history. Some have also made significant contributions to the successful working of the Club.

Dr. William G. Dore

An Ottawa Field-Naturalists' Club field trip with Bill Dore as leader is an experience not soon to be forgotten. His tremendous knowledge of plants, of early settlement in the Ottawa Valley and of the history of Indian travel and village sites, are imparted with typical Dorean enthusiasm. Since he joined the Club in 1944 he has enlivened many evenings with his unique lectures on various natural history topics.

Bill Dore's career as a professional botanist of world-wide reputation may not be as well known to local members. He served as an Associate Editor of the Canadian Field-Naturalist for many years. His studies of Canadian grasses have taken him from Nova Scotia to British Columbia and he has written numerous scientific and popular papers. Local naturalists know him best for his "Grasses of the Ottawa District" and his bulletin on Wild Rice.

Dr. Loris S. Russell

Dr. Russell is a distinguished scientist known internationally as a palaeontologist, having done outstanding work particularly in Alberta and the Cypress Hills area of Saskatchewan. But he is knowledgeable in many facets of natural history. He worked for many years as Geologist and Palaeontologist for the Department of Mines, Chief Biologist at the Royal Ontario Museum, and Professor of Geology at the University of Toronto. He was Chief Zoologist and then Director of The National Museum of Canada at Ottawa. His last position was Chief of Earth Sciences at the Royal Ontario Museum. He has over one hundred publications to his credit, and though retired, is still actively engaged in writing and research. As a member since 1933, Dr. Russell has been actively involved in all phases of the activities of the Ottawa Field-Naturalists' Club, including having served a term as President.

Dr. J. Dewey Soper

Dr. Soper has been a pioneer in biological exploration of Baffin Island, N.W.T., and the western Provinces. He has been a Club member since 1941. From his early teens he was enthusiastically engaged in natural history endeavours, and in the early 1920's explored parts of southern Ellesmere and Baffin Islands. In 1929 he first discovered the nest and eggs of the Blue Goose, *Chen caerulescens*. In 1957, the Canadian Government, by order-in-council, established the Dewey Soper Bird Sanctuary, an area of over 300 square miles in southwestern Baffin Island, in honour of his explorations. In recognition of his accomplishments, a river and lake in southern Baffin Island were named after him. In 1932-34 he covered much of the 17,000 square miles of Wood Buffalo Park making an extensive study of the Wood Buffalo. He has produced many articles and papers on the wildlife of Canada, and books on the mammals of the Prairie Provinces. He has contributed large collections of Arctic plants to the National Herbarium. Though retired he continues to pursue his interests in research and writing.

Dr. W. Austin Squires

A native of Fredericton, New Brunswick, and a Club member since 1922, Dr. Squires is an all-round naturalist with interests in botany, mineralogy, ornithology, anthropology, and history. After receiving a degree in entomology at Ohio State University he returned to his native province, taught school for a number of years, and later became Curator of Natural Science at the New Brunswick Museum, from which he has retired as Curator Emeritus. He has contributed greatly to the wide dissemination of natural history knowledge concerning New Brunswick to school children, youth groups, and the general public by his lectures, and his radio and television series. Dr. Squires has published many articles, essays, and papers on scientific and historical subjects. For

many years he wrote and edited "Nature News" which dealt with the natural history of New Brunswick. He has just published a new book, "A Naturalist in New Brunswick", and is presently revising his useful book, "The Birds of New Brunswick".

DR. ROBIE W. TUFTS

Dr. Tufts, a native of Wolfville, Nova Scotia, has been an outstanding naturalist and conservationist throughout his life. He has been a Club member since 1924. His keenness and infectious enthusiasm have sparked the careers of a surprising number of leading zoologists. Before his retirement, Dr. Tufts was for many years Chief Federal Migratory Bird Officer for the Maritime Provinces. He has published numerous scientific and popular papers and articles. For many years he contributed greatly to the public's awareness of nature by writing a weekly column, "Woods, Water, and Sky", in the Halifax Chronicle-Herald. Since retirement he has remained extremely active and dedicated to the causes of conservation and the environment. Dr. Tufts recently completed a revision of his deservedly popular work, "The Birds of Nova Scotia". His new book, "Birds and Their Ways", appeared last summer.

Report on the I.U.C.N. Meetings in Banff, Alberta September 9-16, 1972

The International Union for the Conservation of Nature and Natural Resources (I.U.C.N.) which has its headquarters in Morges, Switzerland was founded in 1948 in an effort to stimulate international efforts for conservation of significant areas and species throughout the world. Since then it has grown considerably to the point where it has now become a reasonably significant international organization. Its future received a major shot in the arm in 1970 when the Ford Foundation graced it with a $650,000 grant.

The 11th General Assembly and 12th Technical Meeting of the I.U.C.N. at Banff were attended by representatives from over fifty countries, including significant representations from the Third World and from Russia. Unfortunately other countries behind the Iron Curtain were poorly represented.

I had the pleasure of attending and would like to pass on my impressions of the major themes of the conference:

1. Numerous representations from the Third World made it very clear that these countries want their share of the high standard of living enjoyed by the so-called developed world. They point out that conservation and wise utilization of their natural resources is, of course, very important. However, it might not be so important as to impede development should a short term gain in standard of living be available. This will of course continue to be a major point of interface between the Third World and other nations.

2. The first issue was highlighted by careful documentation of the tremendous extent to which unplanned development is going on in the area best described as Amazonia. This is the vast tropical forested area of South America, which up to now has been a major barrier for settlement by Western Man. Today, however, the bulldozers are on the march cutting down the forest to make way for a relatively unplanned and opportunistic form of cattle ranching and farming. This new type of land use takes little account of the rights of native inhabitants of the area and also takes little account of the feasibility of economically operating ranches and farms on a long term sustained yield basis in the tropics. Alternative forms of land use are seldom considered because I suspect the major driving force behind this colonization is the desire of wealthy individuals in these countries to become yet wealthier by expanding the size of their holdings in this new land which is literally coming to them free for the taking. This type of problem illustrates the desire of the Third World to develop and the sort of problems which are generated by this desire.

3. While marginal ranching and agricultural land is now being developed in the tropics, it was generally made clear that throughout the

world in more developed areas marginal land for agriculture was rapidly returning to forest and other uses since it couldn't compete with modern agricultural productivity. To summarize this trend precisely, it was stated that 10% of the land which was previously in agricultural usage in the United States has now returned to alternate uses. I suspect that the same is probably true in Canada. This suggests that unless productive farmland can be fully worked by modern machines and agri-business then its use will probably go to other priorities.

4. My impression from the conference was that within perhaps 10 years literally every square inch of land on the face of this globe will be classified and managed according to some purpose and that all of the vast tracts of *terra incognita* which still exist, especially in the tropical rainforests, and the north, will have completely vanished. It is my further impression, that at best, some of this development will be slightly influenced by ecological and aesthetic principles but certainly the driving force behind the development will be the economic and living standard desires of the people who are directly related to this new colonization.

5. Related to the vanishing of the last frontiers were several long discussions of development in the north, the other frontier which is soon going to be completely divided up into planned and managed units. The Conference dealt with several of the problems related to northern development, ranging from pipeline construction to the construction of the Dempster and Mackenzie Highways. With regard to the first, a detailed summary was given of work in progress in Alaska studying the responses of caribou to pipelines and various attempts to construct pipelines with either underpasses or overpasses in a manner so that these pipelines do not form a barrier to caribou migration. Unfortunately it did not sound as if similar research was being conducted on the potential environmental impact of the Dempster and Mackenzie Highways. Although assurances were made by the Government of Canada that appropriate studies were being done, these assurances were questioned by leading biologists and in fact it seems that full environmental impact analyses are not being done to precede the development of these two highways.

6. I would say that a continuing and emerging redefinition or modern definition of conservation emerged from the Conference, and this could perhaps best be summarized by referring to conservation as 'rational management of land and resources taking into account the dynamics of the ecosystems in question.' This is, I would say, a dominant definition of conservation throughout the world and is prevalent both behind and in front of the Iron Curtain.

7. Some of you may know that one of the important international organizations related to I.U.C.N. is the Survival Service Commission. Its work in the past has focussed on the preservation and protection of individual large mammalian species and according to reports given at this conference, their work has continued to be very successful. They tend to focus on endangered species such as the blue whale, or Bengal tiger and it is very obvious that a specific focus such as this (i.e., not focussing on ecosystems but relying heavily on the appeal that species like this have to people) can be very successful. I think what it means is that funds can be obtained for both research and study of these spectacular large mammals and that by having this information available, sometimes new avenues of hope are opened up for these species.

8. I would be remiss if I didn't report a decided impression which I had of the conference and that was that delegates were in general members of a very elite, selected, and very well educated group, who have in general for many years been travelling around the world enjoying the charms of the special spots of beauty and wildlife lore that can be found on our planet. Although there is a growing awareness of the needs of the average human being in under-developed, as well as developed, countries, in general I think the conservation people who have focussed on reserves and natural areas have not been as realistic as they could have been in relating the potential benefits of these areas to the overall economies of the countries and the very real needs of the often poverty-stricken masses of these countries. Of course, this is a very difficult issue, especially if you accept my definition of conservation as rational management of resources. Anyway, this was an impression which I carried away and I would not like to imply that it was any more than a personal opinion, gained as a result of a somewhat superficial exposure to this internationally august body of conservation experts.

9. One of the positive programmes that emerged from the conference, was that the I.U.C.N. would look very seriously at international support for wildlife and natural lands in the under-developed countries. This reflected the fact that many under-developed countries said they would like to protect such and such a resource but they had no money. Their needs were related to feeding their people at present. It was strongly suggested that the developed countries whose people utilize these resources on their international treks should find ways and means of supporting these resources in the under-developed countries. In fact, I think something will probably come of this suggestion.

10. There was a very strong point made several times about the value and importance of preserving genetic diversity in animal and plant populations throughout the world. In this regard, diversity was related: a) to the stability of the ecosystems; b) to its role in providing a resource bank for future breeding experiments which might have products useful to man; and c) to man's responsibility for stewardship for the rest of the world. Unfortunately, I think that none of these arguments is completely convincing by itself and that to prevent the extinction of numerous species within the next 10-20 years, the conservationists are going to have to come up with either a new world ethic or a new world logic.

Finally, there was a very hot debate on a very specific issue that related to whether or not I.U.C.N. should have supported a complete moratorium on whale hunting. Some of you may know that one of the recommendations of the Stockholm Conference was that a complete moratorium be declared for five years on the hunting of whales. I.U.C.N.'s opinion was that this was not necessary on all species as the Stockholm recommendation read; I.U.C.N.'s position was based on scientific estimates of population numbers. Many members of this conference, however, felt that I.U.C.N. should have erred on the side of being conservative because of the difficulties in enforcing hunting quotas and regulations. These members pointed out that it was very easy to enforce a regulation that no ships should go out whaling. However, it was very difficult to see if a ship had more than its quota or if it was taking whales under legal maximum size.

These were the major impressions which I gained from attending four days of technical meetings associated with the conference. Unfortunately I missed the last two days when resolutions were passed by the delegates.

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International Symposium on Moose Ecology

Symposium International sur L'Ecologie de L'Orignal

Quebec, Canada 25-30 March, 1973

The tentative program includes presentation of papers on the following topics: habitat distribution; behavior; management; nutrition; population dynamics; moose coactions; and a general discussion. The North American Moose Workshop will convene for the 9th time on March 29, 1973.

For further information contact:

Jean Bédard, Chairman
International Symposium on Moose Ecology
Département de Biologie
Université Laval
Québec, Canada.

The Canadian Botanical Association

L'Association Botanique du Canada

The 1973 Annual Meeting will be held from June 3-7 at The University of Western Ontario, London, Ontario, Canada.

The main theme of this conference will be "Man's impact on the Canadian Flora". There will be a day-long symposium on this topic plus a full day, within-conference field trip to examine the effects of man's activities in this highly populated area of Canada.

Also included in the conference will be meetings of the ecology, systematics and phytogeography, mycology, phycology, paleobotany, and general sections of the C.B.A./A.B.C.

For further information please contact:

The Chairman, Local Arrangements Committee,
C.B.A./A.B.C. Department of Plant Sciences,
University of Western Ontario, London 72, Ontario

Book Reviews

BOTANY

Trees: Structure and Function

By Martin H. Zimmermann, Claud L. Brown and Melvyn T. Tyree. Springer Verlag, New York, Heidelberg and Berlin. 1971. 336 p. 134 illustrations. $19.80.

At one time or another most students of physiology come into contact with d'Arcy Thompson's book "On Growth and Form". Although this thousand page work is dated (1942), the reader cannot fail to be stimulated by the description and discussion of relationships between the form and the function of plants and animals. The reader is made aware of the beauty of nature's designs, and finds satisfaction in the good reasons for living things being constructed as they are.

Since Thompson published this work the physiological aspects of plant structure and function have been developed, and "Tree Structure and Function" is a major contribution to this field of work. It is all the more welcome since the trend to using more easily manipulated plants such as algae, fungi and a small number of herbaceous plants for physiological studies has diverted attention from whole tree physiology.

The book is devoted "to those aspects of structure and function which are peculiar to trees". The authors do not attempt to cover "such basic processes as photosynthesis, respiration, metabolism, nutrition or other topics common to all green plants". The emphasis is on trees, and stresses the relationships between structure and function, and how trees work. The authors do not state specifically the audience for which the book was designed, but the publication will be mainly of value to people with physiological training.

There are seven chapters, each of which is essentially a review paper, covering primary growth, secondary growth, growth and form (all by Claud L. Brown), transport in the xylem, transport in the phloem, storage, mobilization and circulation of assimilates (all by Martin H. Zimmermann) and a chapter on steady state thermodynamics of translocation in plants by Melvin T. Tyree. The book has obviously been produced with great care; the print size is well balanced with page size, the off-white matt paper makes for restful reading, and nearly all the illustrations are well balanced. The publishers, who usually put out a polished product, have excelled themselves. One minor criticism is that the continuous method of listing literature cited is less easy to scan than when each reference begins on a new line, but it is appreciated that the former is more economical. As far as it goes, the subject index is well done, but is a little meagre for most purposes. Citation of the book may cause some difficulty, as one is not quite sure whether or not to include Melvin T. Tyree as one of the authors.

All the main topics are treated in considerable depth, and cover most of the relevant literature. The section on extension growth of shoots is unusually comprehensive, covering both roots and shoots, and points out the shortcomings of earlier texts. For example, many publications perpetuate the misconception that the small, non-vacuolated cells of the apical meristem are the most important sources of extension growth. As this book points out (Chapter 1), the majority of the primary plant body cells are produced in the sub-apical region, a fact clearly shown by Harting in 1845. Cell divisions occur at considerable distances below the apical meristem in highly vacuolated cells of the pith, cortex, and vascular procambium — a fact that is often forgotten.

Mycorrhizal associations are dealt with briefly, and the authors point out that while these associations are beneficial to trees growing under natural conditions and may be essential on soils low in nutrient supplying capacity, they are not necessary for the normal growth and development of seedlings adequately supplied with nutrients. For a time many foresters believed that mycorrhizal associations on trees were essential in all situations, and it is as well that this point has been made.

The discussion of secondary growth deals concisely with the origins and evolution of the vascular cambium and different cell types, the patterns of cell division and hormonal control, and correlations between primary and secondary growth. The description of root growth is brief and informative, but leaves one aware that we still know relatively little about tree root growth and processes.

Claud L. Brown's chapter on growth and form is fascinating. He discusses the physiological differ-

ences between trees and shrubs and the effect of various factors on tree form in a direct simple manner that will appeal to a wide range of readers. Although the genetic control of form is only mentioned briefly and some tree geneticists will be disappointed if they look for a detailed discussion of genotype-environment interaction in relation to tree form, this does not detract from the chapter which deals strictly with physiological aspects of growth and form with few distractions.

Martin Zimmerman's two chapters on transport will be welcomed by most tree physiologists and students. A great deal of material is brought together and presented in a concise and direct style. The author has managed to perform the difficult task of presenting a well balanced description and discussion without losing his reader in a morass of qualifications. The section on resistance to flow in the xylem is particularly well done.

The chapter on steady state thermodynamics of translocation by Melvin Tyree is a useful supplement to the earlier chapters on transport. It may be rather a shock to some readers to suddenly come upon the harsh realities of physics after a more leisured intellectual journey through the previous chapters; some may skip the chapter and others will try to bring their physics textbooks to their rescue, depending upon their tenacity. Those who skip the chapter will miss something worthwhile.

This book is a well produced, scholarly work and will be invaluable to anyone concerned with tree physiology. Reviews and syntheses of broad fields are all too often a catalogue of facts with no discrimination between the good and the bad, the false and the true. Others lose the reader's interest in digressions, or belabour him with up-to-date jargon. The authors of this book are to be congratulated; they have not only described existing information but discussed it in a cool critical manner. Many people will recommend this book for their libraries, and even purchase it for their own bookshelves.

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The Illustrated Flora of Illinois

By Robert H. Mohlenbrock. Southern Illinois University Press, Carbondale, Ill. 1970. Flowering Rush to Rushes. 272 p. $10.00, and Lilies to Orchids. 288 p. $10.00.

The above two volumes are the continuation of a series on the Illinois flora edited by Robert H. Mohlenbrock. Although a number of other floras of geographic areas, states or floristic regions exist, most are incomplete in either content or coverage, but this series has as its aim the production of keys, descriptions, maps and illustrations of all groups of plants to found within the borders of the state of Illinois.

Although it is the intent to draw upon the services and advice of specialists, the number of them is necessarily limited and will result in the editor becoming author of much of it. In the first volume, for example, assistance was obtained with the taxa *Najas, Zannichellia, Juncus,* Lemnaceae, *Sagittaria* and part of *Potamogeton.* This accounts for 8, 2, 48, 16, 17 and 42 pages respectively (including drawings) or a total of 137 pages out of 272. In the second volume credit is given for comments on *Trillium* (not necessarily written by the critic), for 14 pages, which leaves 274 written by the editor/author.

In the first volume (rushes) there is a tabulation of the illustrations, a foreword and an introduction, after which there is a discussion of the morphology of the monocots of Illinois. The sequence to be followed in the treatment (Flora of North America sequence) is discussed and a short paragraph on how to go about identifying the plants follows. The second volume follows the same arrangement but omits the morphology discussion. Then follows a key to families and some genera. Each Order is described and a key to the contained families given. Within each family there is a key to genera and within each genus a key to species. For each species principal synonymy is given followed by a description and chromosome number when known. Common name, habitat, range and Illinois distribution accompanied by a map. No flowering or fruiting times are given. The maps show one dot in the center of each county, a method which suggests Deam's Flora of Indiana and one which is practical when the counties are relatively the same size as it turns out they are in Illinois, but which would break down in a state where they are less uniform. At times one is uncertain to which species the map refers, suggesting that perhaps the maps should be inserted in the figures. This arrangement would also be more concise.

The size of this undertaking is impressive. Six volumes are planned for the Monocots only, the third and fourth volumes will cover the grasses, the fifth and sixth, the sedges. The publisher does not commit himself on the number planned for the dicots, but we can estimate from previous floras of Illinois, as that of Jones, that there would be approximately three times as many dicots. This estimate suggests another 18 volumes for a total of 24 and the gymnosperms, mosses, hepatics, fungi and algae which the advisory board has decided to cover, have to be added to that figure. The ferns have been completed (Mohlenbrock, R. H. 1967. The Illustrated Flora of Illinois. Ferns. Southern Illinois University Press. Carbondale. xi - 191 p.), but are not mentioned in the forward to either volume.

These books are very attractive, the covers are a soft green color with a green dust jacket on the first and a mauve one on the second. Every species is beautifully illustrated with full page drawings in most cases. There are 108 of them for the rush book and 133 for the lily-orchid book, most of them done by Miriam Wysong Meyer. She should be congratulated; her drawings make a significant contribution to the usefulness of the books.

The literature cited at the end of the lily book is additional to that cited at the end of the rush volume. The list is quite useful and, while not extensive, consists of well-selected references which quickly lead one into the literature on the topic. There is a list of excluded species at the end of each volume and reasons are given for excluding them. We also find a compilation of the number of genera, species and varieties treated in each volume. I should like to suggest that the editor consider the possibility of listing the volumes in the series which are already published at the end of each volume as it appears because the existence of the fern volume, for example, was only suspect from the comments given on the inside of the dust jacket and no actual reference could be found.

Considerable variation in the length of the species descriptions is evident which leads one to suspect that they were shortened in order that the two volumes would be approximately the same size. Probably, however, it means that some descriptions were written with the aid of existing monographs but others were not. For example, the description of *Sagittaria* species (for which there is a monograph and where aid was supplied by a specialist) is lengthy, but those for *Sisyrinchium* are short.

My chief criticism of this series is perhaps the obvious waste of space. For example, when a drawing does not completely fill a page, the rest of it is merely left blank. This could have been avoided by using the small (too small) distribution maps as inserts on the illustration or even by combining some illustrations into composite plates. This space waste is especially evident in some of the *Potamogeton* species. The thick paper used in the text does not do anything to alleviate this impression.

Because of its thoroughness and size, the books of this series will be very useful laboratory tools but somewhat awkward to carry into the field. I doubt, too, if the maps are especially significant. In terms of total plant range in the U.S.A. or in North America, Illinois comes out rather a small patch, so the only really significant maps are those of species that are confined to one corner of the state or otherwise have some special distribution feature within the area.

On the whole, the series is thorough, comprehensive and neat, deserving a place on the library shelf (or shelves). Let us hope that this rather ambitious undertaking can be carried successfully through to completion.

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ZOOLOGY

The Fisherman's Handbook: A Complete Guide to Fishing in North America

By John Power and Jeremy Brown. Charles Scribner's Sons, New York. 1972. 192 p. illus. $6.95. Available in Canada from Burns & McEachern Ltd., 62 Railside Rd., Don Mills, Ont.

This book is a handy introductory guide to freshwater fishing in North America. Basic gear terminology, often glossed over in other books, is here explained in a condensed style, that, if barely literary, packs the information in. The book, written by two Canadians, published by an American book company is aimed at an American and Canadian audience.

Chapters on gear, techniques, pollution and cooking are included. The penultimate chapter treats the major game fish one by one under the

headings, Spawning habits, Appearance and Angling tips. Also included are distribution tables, one of the more innovative features of the book, which describe the abundance, the average and record size for each province or state where the species is fished for. The identifying characters mentioned under Appearance are sometimes not the best and there is somtimes confusion in nomenclature; these would have benefited from checking by an ichthyologist. Occasional errors such as reporting the blue catfish for Ontario, are found.

In the last chapter the states of U.S. and provinces of Canada are listed alphabetically. Under each is given the address of the fisheries department, a brief description of the major sport species, and a few suggested fishing hot spots.

The first half of the book would be useful to the beginning angler. The second half might provide useful regional information to the fisherman going to fish outside his own province. It is not, as claimed by its subtitle, a complete guide to fishing in North America.

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Freshwater Fishes of Manitoba, checklist and keys

By Alex N. Fedoruk. Manitoba Department of Mines, Resources & Environmental Management, Winnipeg, R3C 0V8 1971. 130 p. 110 figures. $1.00.

Freshwater fishes of Manitoba is a delightful pocket-sized guide to the identification of the 84 species of fish known to occur in the fresh-waters of the province. The keys are thoughtfully designed to assist the amateur in identifying specimens in hand. Two or more diagnostic characters, usually in opposing pairs in the couplets, are presented at most points. There is a drawing, sometimes supplemented by a figure of the young or anatomical details, for each species. There is no attempt in the drawings either to show or to imitate fine details. Clear and careful outlines show the essential shape and form, with stippling to show diagnostic colour patterns where necessary.

Lists of verified species, possible records, and unacceptable records, a section on fish identification, and a glossary precede the body of the text which is comprised of keys and figures. Possible species, which have not yet been recorded from the province are usefully so indicated and included in the keys. A list of references and an index complete the title volume.

There are a few minor technical errors such as the spelling of ichthyofauna (p. 1) and *Perca flavescens* (p 100), and the definition of Body Depth (p 27). Introduced fish are not distinguished from native fish. The headings and captions are sometimes misplaced so that it is not immediately apparent to what they refer. It is doubtful that the glued binding will stand up to use in the field.

The book is a handy pocket size, yet not so small as to restrict the illustrations. Matte paper, serviceable for the field was chosen. The cover design is pleasing. This useful booklet worthily fulfills the goals it sets out to attain.

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The Blue Whale

By George L. Small. Columbia University Press, Irvington, N.Y. 1971. 248 p. $10.95.

This book is a scholarly historical account of the decline in the population of Antarctic blue whales under pressure from the whaling industry; of attempts by the International Whaling Commission to control the fishery, which may may be characterised as "too little and too late"; and of the Commission itself.

As a monograph on blue whales, however, it is inadequate, not only because the author has not sufficiently researched the biological literature, but also because he seems determined to prove that the blue whale is approaching extinction, and that the I.W.C. is some kind of sinister conspiracy. As a biologist, I must attempt to redress the balance by what may seem to some, in contrast, as over-optimism.

Populations of blue whales exist in all the world oceans — Southern plus Indian, North Atlantic,

and North Pacific. The tropics act as barriers to dispersal across the equator except perhaps in the Indian Ocean. The sub-Antarctic pigmy blue whales apparently represent a separate population but probably not a separate subspecies from the typical, giant-sized Antarctic blue whales. The Antarctic population was also the largest in numbers, in conformity with the great extent of this sea. Worldwide protection was given to blue whales in 1966, by which date Antarctic and North Pacific populations were indeed small, so that their recovery will be very slow. However in the North Atlantic, protection was given in 1960 (ratified last by Iceland in 1965). Moreover, the I.W.C.'s predecessor banned factory-ship whaling in the North Atlantic in 1938 so that hunting of large whales was confined to areas within reach of catcher vessels from land stations. Canada last caught blue whales from such sites in 1951. The population in the northwest Atlantic was indeed reduced, chiefly by land-based whaling in 1898-1915, and by pelagic catching in the 1930's. The species still exists, however, and can be seen by those able to identify it, in waters as close to Canadian population centres as the Gulf of St. Lawrence and off the Nova Scotia coast. There are four authenticated strandings of blue whales in eastern Canada since 1949, three of them in the St. Lawrence estuary (Sergeant, D. E., A. W. Mansfield and B. Beck. 1970. Inshore Records of Cetacea for Eastern Canada, 1949-1968. Journal of the Fisheries Research Board of Canada 27: 1903-1915) where they may on occasion collide with ships.

The I.W.C. and its predecessor, with methods of management employed to date, have been unable to control levels of catch, it is true, but ultimately, rare species have been protected, and contrary to the statements of Small, have increased again. Species protected in this way in the 1930's — bowheads, right whales, and grey whales — have all returned in varying degrees in different parts of their ranges. (Canadians, again, may be glad to note that for example, right whales can be seen — in proper season — off Passamaquoddy Bay, bowheads off Baffin Island or Banks Island, grey whales off Long Beach, Vancouver Island.) We may thus expect blue whales to recover also, at different rates in each ocean basin. Humpback whales, also protected everywhere in the mid 1960's, are already common in the Northwest Atlantic, though rare elsewhere.

One popular legend, echoed by Small, is that rare whales may be too thinned out to locate each other. Whales are not evenly distributed over the high seas, however, but are often relatively coastal-living or attracted to the Continental Slope, and may either congregate in areas of dense food, or follow traditional homing patterns. There is no evidence of an ultimate failure of populations of right whales, bowheads or grey whales to increase, unless totally exterminated, as was the Korean population of grey whales. A very slow rate of increase over 50 years by bowheads of the eastern Canadian arctic in the absence of human predation is puzzling but may perhaps be attributed to an increased rate of predation during the phase of rarity by killer whales. At any rate, this population appears very recently to have arrived at the stage of acceleration of increase (Mansfield, A. W. 1971. Occurrence of the bowhead or Greenland right whale (*Balaena mysticetus*) in Canadian arctic waters. Journal of the Fisheries Research Board of Canada 28: 1873-1875) and can be expected soon to spread eastward again to colonize its old range around Greenland and Spitsbergen.

Fortunately, the I.W.C. began in 1972 to regulate catch at or below the level of sustainable yield for the major world populations of fin, sperm, sei, and minke whales, which had either sunk to sub-optimal levels or were under heavy exploitation. Five major species after overexploitation have therefore been protected and may be presumed to be increasing, while four are under controlled exploitation. Extinction of any major population or species of great whales is now improbable.

We seem to be entering a phase of intensive popular interest in the Cetacea. This began with the kind of reaction demonstrated in this book, a reaction against the continuation of excessive levels of catch by the whaling industries. Professionals can only welcome the end of a long era of neglect.

Scientific names of species mentioned are as follows: blue whale, *Balaenoptera musculus*; fin whale, *B. physalus*; sei whale, *B. borealis*; minke, *B. acutorostrata*; humpback whale, *Megaptera novaeangliae*; bowhead, *Balaena mysticetus*; right whale, *Eubalaena glacialis*; grey whale, *Eschrichtius gibbosus*; sperm whale, *Physeter catodon*; bottlenose whales, *Hyperoodon* and *Berardius* spp.

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Behaviour of Wolves, Dogs and Related Canids

By Michael W. Fox. Jonathan Cape Ltd., London. 1971. 214 p. $14.50. Available in Canada from Clarke, Irwin & Company Limited, Toronto.

Most of the effort in wolf research has been oriented so far towards elucidating the predator-prey relationships and the habits of the wolf in its natural environment. This emphasis has been so largely because the subject of the wolf as predator traditionally has been an area of public concern. Now a book has appeared which in large part is an examination of a more neglected aspect of the life of this fascinating species, the development of its social behaviour.

Almost all of the few important studies of the social behaviour of wolves, including Dr. Fox's own researches, have been conducted in captive situations because this subject is perhaps the most difficult to be conducted in the unfettered freedom of this shy species' natural environment. The author quite rightly points out at the outset of his book that there exist important limitations in such studies of captives. In my experience, these limitations are most apparent in the lack of opportunity they afford to demonstrate the full range of social roles that can be played by other members of what is a normal group, that is, one that often includes yearlings and older, non-parent members.

For the reason that the behavioural study of wolves in captivity does impose limitations on the conclusions that can be reached, the author has drawn on what little published and unpublished material on the subject that he could find. Thus this book, serving as it does as a review of most of what is known of the behavioural development of the wolf, should serve well as an impetus to the further elaboration of this subject in the field.

Yet, as its title indicates, this book is not solely about the wolf, although by far the most space is devoted to that species. The author's intention is to compare the development of social behaviour of several canids, particularly the wolf, the red fox, the arctic fox, the grey fox and the coyote. The author has combined his own observations on hand-reared subjects of each of these species with the observationes of other workers and has succeeded in producing a worthwhile volume on comparative canid ethology.

I am somewhat surprised, however, at the author's omission of any reference to an important work on the arctic fox (Macpherson, A. H. 1969. The dynamics of Canadian arctic fox populations. Canadian Wildlife Service Report Series No. 8. Ottawa), considering the relatively small amount of literature that exists on that species. Especially pertinent to the book are Macpherson's considerations on spatial distribution of den sites and causes of whelp mortality.

This book will be of interest not only to the specialist but also to the general reader who has an interest in dogs as pets. After a review of the characteristics of members of the Family Canidae in Chapter I, the author leads his reader from a general consideration of canid behaviour, and more specifically, the comparative behaviour of the foxes, the coyote and the wolf, through several chapters devoted almost entirely to wolf behaviour, and finally to an examination of the social behaviour of the domestic dog with comparisons to that of the wild canids.

Of the few typographical errors that occur in the work, three are particularly glaring: the captions to Figures 2(a) and 2(b) no page 92 are interchanged; a line of text is misplaced and another missing on page 116; and the name "Burkholder" is misspelled on page 138 and again in the References.

The book is profusely illustrated with photographs which are remarkably well-positioned with respect to the appropriate text. Only one or two of the photographs could have received greater attention in the darkroom in order to highlight the feature being illustrated.

This book is a worthy addition to the growing bibliography on wild canids, and especially to the ethological literature on the wolf. It is hoped that its greatest value will be to serve as an impetus to more detailed research on the social behaviour of all canids, an despecially to greater efforts towards elucidating the social behaviour of the wolf in the free state.

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ENVIRONMENT

Persistent Pesticides in the Environment

By C. A. Edwards. Chemical Rubber Co. Press, 18901 Cranwood Parkway, Cleveland, Ohio 44128. 1970. 78 p. $10.50.

In a very small volume, Edwards presents a very concise summary of data relating chiefly to the persistence of chlorinated hydrocarbons in soils, air, water and in the biota. The book is a tribute to the author's knowledge and expertise in this specialized field.

I personally feel that the first two chapters are more informative than the third chapter which concerns the possible control of persistent pesticides in the environment. In general, the author is optimistic about man's capability of using insecticides widely and his ability to develop safer and better insecticides. Comments illustrating this are: *"The potential hazards of insecticide residues in soils are probably not great, but the soil does constitute a reservoir of these residues, which may move into other parts of the environment"*, and, *"Current evidence indicates that hazards from pollution of the atmosphere by pesticides are still small, particularly compared with those from pollution of air by other materials"*. The latter statement is currently in dispute by many scientists including the M.I.T. group in their publication, *"Man's Impact on the Global Environment": Report of the Study of Critical Environmental Problems (M.I.T., Cambridge, Mass. 1970, pp 126-131)*, and recently by *Goodwell et al., (Science* **174,** *1101 (1971)* who claim that movement of residues in the atmosphere is the most important transport route of DDT in the environment. Their thesis states that residues are volatilized from the earth in to the atmosphere, removed from the atmosphere by rainfall, and are diffused across the sea-air interface. This thesis conflicts with Edwards' statement, *"indeed it is difficult to see how large amounts of pesticides could reach sea water"*. Edwards' statement that there is no conclusive evidence that the survival of any species has been threatened by the use of insecticides remains very controversial. R. W. Gould (*Bulletin of Environmental Contamination and Toxicology,* **8,** *84 (1972)*, says, *"The Brown Pelican (Pelecanus Occidentalis) has shown dramatic population declines in North America, particularly in the States of California, Texas, Louisiana and more recently, South Carolina. In California, for example, the Brown Pelican is no longer considered a breeding species"*, and further, *"Much of the problem manifests itself in the thinning of the pelican eggshell. Thinning and breakage of the eggshell is believed to be the result of inhibition of carbonic anhydrase by DDT and its metabolites"*. However, in all fairness, we should admit that at least two years of additional research on DDT transport problems as well as DDT's relation to bird populations has been carried out since this review was written.

Chapter one gives an excellent over-view of persistent chlorinated pesticides in soils, air, and water. Much data is concisely outlined in various tables enabling the reader to make a quick survey of residue levels of DDT, aldrin, endrin, BHC and others in various areas of the environment. This condensed appraisal of the residue situation is in attractive form for the general reader who has not been specializing in the pesticide area.

Chapter two contains valuable information on the occurrence and persistence of chlorinated insecticides in soil flora and fauna, aquatic organisms, plants, vertebrates, human food and human beings. This will prove very useful to many non-specialists who need a general survey of the field but who may not have the time to read extensively in the literature. I should mention that the bibliography is excellent.

Chapter three reviews various ways to control persistent pesticides in the environment. In this chapter, the author says that many new organophosphates or carbamates are being developed which have a persistence of less than a year. While this may be generally true, there are a number of notable exceptions in the organophosphate field. Some of the new organophosphate compounds are showing considerable stability in certain types of soils. An important fact today, however, is our capability to detect very low levels of insecticides with the recent advances in analytical techniques. One wonders in retrospect what the present residue situation would be like today if the current sophisticated analytical techniques and improved spray methods had been available thirty years ago.

Edwards ends on the happy note, *"It does not seem that the present situation concerning pesticides in the environment is too serious. Many resources are being expended to develop alternative chemicals or methods of pest cotnrol and the environment is already being monitored for residues"*. While I tend to share the author's optimism, many scientists would disagree with the above statement.

In practical terms, it seems there is no adequate substitute for chemical control of insects in the forseeable future. Biological control certainly has possibilities but seems no general substitute at this time. With an expanding world population, the options to chemical control of insects do not seem very attractive at the moment. Certainly the concept of slow release insecticides which will control insects with minimum input of chemicals into the environment is an attractive alternative to the older methods of pesticide application.

The author has added to this work an appendix on legislation on persistent pesticides during 1969/70 in various countries. This is one area which is constantly changing but the appendix is a very useful summary of legislation relating to chlorinated pesticides at that time.

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The Fight for Quiet

By Theodore Berland. Prentice-Hall, Inc., Englewood Cliffs, N.J. 1970. 370 p. $8.95.

In a recent survey conducted by Pollution Probe at the University of Toronto Noise trailed Air and Water pollution as a menace to health and to the environment in the opinion of the public. When we know that we begin life with a fixed complement of cochlear "hair cells", the essential component of hearing, which can never be replaced, then our disregard for their health and welfare is alarming. That we consent and contribute towards an evermore noisy attack on ourselves and our environment must result from a youthful or occupational indifference, a purely acquisitive greed, an engineering, or other scientific ignorance or total disinterest. Man is supremely destructive to his World with Noise one of the most active secret agents in our lemming-like rush to annihilation. That is what this book is all about.

In The Fight For Quiet, Berland has hit all the information highs and plummeted to the abysmal lows of the present state of knowledge concerning all facets of Noise. He outlines the physics, biology and psychology of noise, and tells us how to protect against it. The chapter on noise abatement in home, office, industry and "high rise" could be excerpted and distributed to all builders and occupants of our dwellig units.

Somewhat less effective and accurate are the outlines of the physiology of hearing and the psychology of unwanted sound, possibly because of the need for simplification since this book appears to be aimed at the completely uninformed reader. For the more scientifically educated, an extensive bibliography of "Sources" is appended and these include most of the better known works on noise. With these each area can be studied in detail though a certain amount of the references are newspaper and magazine articles etc.

Most unfortunate is the inclusion of 34 pages on "How Noise Can Kill" and "How Noise Destroys". In the present state of rapprochement between the "Big Powers" much of this material seems more likely to confuse and alarm the reader, than to inform. After all, poison gas, atomic fall-out and "weapons of death" are a minor threat to our future generations compared to the insidious involvement of all life on this hopefully green and blue space ship in the deleterious effects of noise.

In one area the "Fight for Quiet" deserves a really enthusiastic endorsement. As an overall review of the nature of noise pollution, its sources, its harmful effects and how and what to do about it, it belongs in the library of every citizen. Unfortunately the personal diary of a sound level recordings by Mr. Berland in his travels to Europe and across North America while researching this book should not be used as anything but a reflection of the interest and intensity that he puts into the preparation of a book. They should not be used by other investigators due to the nature of the recording device and the impossibility of calibration etc. or the unreported characteristics of the site.

That this book has been an effective "seller" is shown by it having had a Second Printing in April 1971 but the description on the jacket might well have been written by those who put scantily dressed statuesque girls on the covers of re-issued Perry Mason novels.

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Fundamentals of Ecology

By Eugene P. Odum. W. B. Saunders and Co., Philadelphia and Toronto. 1971. xiv + 574 p. $12.10.

Most of us have been influenced in one way or another by an earlier edition of the familiar "Odum". Publication of a new edition, extensively revised and greatly expanded, is therefore a matter of general interest. If you have read an earlier edition, you will find the conceptual approach and basic perspectives unchanged. But comparisons with earlier editions are irrelevant when the primary consideration is the new edition's adequacy as a teaching device. Specifically, does it compare favourably with its competition, and does it provide the beginner in ecology with a good overview of the field? By the competitive criterion, the text is admirable. Once again, the best available university text for a first course in ecology carries the Odum name. But in view of the relatively feeble competition, perhaps I should add that the new edition is also a good introductory text by many other standards. The evidence, in short, is that the Odum dynasty, quite apart from its other contributions to ecology, will continue to exert an important didactic influence on the field.

But having said that, it is also the reviewer's task to identify deficiencies. According to its Preface, the book is designed to satisfy three separate teaching functions. In the first of these roles, it will serve admirably for undergraduate students in disciplines other than ecology. Its deficiencies do not seriously compromise its coverage of the essentials for those who wish a modern education. For undergraduates intending to continue in ecology, the book's inadequacies will require a considerable supplementary effort by the professor, in particular because of its weak treatment of mathematical ecology. I suspect that the uninitiated reader will be left with the feeling that the real action in mathematical ecology is inextricably related to the "number-crunching" capacity of big computing machines. In truth, little of demonstrable merit has yet been achieved by such methods, in comparison with the well-developed utility of less dramatic methods. The application of machine computation to ecology is a development of major importance, but it has not yet obviated the necessity to think and to understand, and the student who is not led to this understanding with the aid of conventional mathematical analyses is indeed cheated.

It may be that Odum's teaching experience has led to the text's weak treatment of mathematical ecology. Biology students are widely supposed to manifest mathematical ineptitude. But if Odum has deferred to this aversion, he has not done the student a service. Many of the more exciting current developments in ecology, including growth, production, distribution and stability theory, depend on mathematical analysis. In my view, the test of an introductory course for specialists is that it should prepare the student to use the current literature. On these grounds, Odum's text is quite deficient. Fortunately, it happens that several currently available paperbacks cover the mathematically deficient areas inexpensively and well, so the text can still be recommended for undergraduate biologists, although I personally doubt that it or any other general text is really indispensible for this application. By the same reasoning, I do not accept its usefulness as a graduate text, although it would be valuable as an introductory reading assignment for graduate students transferring to ecology from other disciplines.

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Highways and our Environment

By John Robinson. McGraw Hill Book Company, New York. 1971. 340 p. $24.50.

The theme concerns Man's need for mass transportation and his current desire not to destroy his environment in meeting the need. The author has separated the basic problem from the ad hoc solutions which, in the past, have complicated the problem rather than leading to a solution. The author has reviewed a variety of solutions. He reminds us that nothing else has exacted such a high cost in sacrifice of human lives and in outright destruction of the earth's resources as the motor vehicle, while at the same time providing comfortable and convenient travel to that part of the world's population which makes use of it.

If we heard of a society in another world that was so eager to have transportation convenience

that it made an annual sacrifice of 55,000 human lives, we would think, and rightly so, that they were mad. If they added to the human sacrifice the destruction of the cities painstakingly built up over centuries and the destruction of 4% of the total landscape of the country we would be even surer we were dealing with madmen. Those figures relate to North America of the 1970's. We have not mentioned the impact on the world's biosphere of the release of hundreds of millions of tons of gaseous and solid residues from motor vehicle exhausts and the physical problem of getting rid of 10 million used vehicles a year.

The book deserves to be on a best seller list. Its high price will undoubtedly keep it a library item. Those who may have access to it through libraries should read it, not just for a broad approach to an old problem, but as a source of statistics with which to confront politicians and other decision-makers when discussing future programs for further destruction of the biosphere to provide for the demands of the monster we fondly call "our car".

We have heard of the possibility of technology becoming the master of Man and of relieving Man both of the need of making choices and of the ability to implement them if he makes them. We have almost reached that stage in the subserviance of all our other interests to the motor vehicle. Let us hope that books like this one will help us to regain a true perspective and encourage us to take more positive steps to regain mastery of our environment, our vehicles and of our future.

The book is very well illustrated with almost as many photographs as pages. Many of the pictures make their points more emphatically than words alone could.

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OTHER BOOKS

Twenty-one Popular Economic Fallacies

By E. J. Mishan. Allan Lane, The Penguin Press, England. 1969. 245 p. Available in Canada from Longmans Canada, Don Mills, Ont. $7.75.

Our modern industrialized media dependent society runs on myths. Mishan's book squarely tackles many of the myths that underlie the statements of government, industry and trade-union spokesmen. The unsupported statements of our various leaders are seen by Mishan to drive our industrialized societies in ways that people really don't want and wouldn't allow if only all of the facts were widely known. In this book fallacies are discovered, somewhat laboriously explained and easily dispatched. The following general areas are covered: taxes and controls, business, international trade, impact of migration, economic growth.

Mishan understandably has a United Kingdom point of view and therefore many of the fallacies that he uncovers are of little direct interest to the Canadian reader. However even the chapter entitled "On the Pound being in Danger" (subtitled "When the pound is in danger the country is in danger") is illuminating for those who have tried to make sense of a monetary crisis in Canada by following the printed statements of bank, government and industry spokesmen. Clearly Mishan concludes that when the pound is in danger the country is *not necessarily* in danger.

Mishan's attack on widespread economic fallacies is based on an attempt to show that many statements used in the premise or conclusion of an argument are false. In separate chapters the author exposes the following fallacious statements: "faster economic growth helps the balance of payments" (the opposite may be true); "faster economic growth checks inflation" (true in certain restricted cases); "economic growth removes poverty" (poverty is a relative concept); and "economic growth enriches society" (may be no way of measuring whether we are getting better or worse off).

Much of Mishan's reasoning is based on arguments seen in his earlier book *The Costs of Economic Growth* (see CFN 84(2):195 for review) where he develops the notion that our market system is largely inoperative because of externalities or spillovers. External costs and benefits are not registered (even if they could be calculated) and since the full costs and benefits of economic transactions are not known our

society is involved in a massive misallocation of its resources. For this reviewer Mishan, however, uses the externality case a little too often. It enters again and again in a *deus ex machina* way to disprove fashionable arguments. While externalities are largely unquantifiable Mishan cites them to prove an argument and dismisses them when doing so would prove him wrong. For example, in two chapters on the "brain drain" he is loathe to admit that external benefits accrue to the activities of the scientists and engineers of a particular country (see especially p. 211). In an earlier chapter (and elsewhere in the book) he notes that farming may be characterized by favourable spillover effects. (p. 93) ". . . farming should be encouraged by paying to farmers a subsidy equal to the extra (non-marketable) benefits they confer on the country at large."

Our society has a Chamber of Commerce mentality and Mishan's book should do much to expose many of its economic myths. However, myths take a long time to die and just when they appear to have been laid to rest they tend to reappear in a new form. Mishan seeks a broadly based informed debate on the economic and social consequences of government actions. As he notes in the Preface (p. 9) "to some extent, the lack of critical public discussion on such issues is a result of both government and opposition leaders being under the influence of the same obsolete 'forward-looking' liberal ideology. And it is no comfort to know that in these turbulent days the country is still in the hands of men whose political responses are habitually guided by the economic presumptions of a bygone era; men who appear to regard it as self-evident that any increase in the speed of economic growth, any rise in the rate of technological innovation, any increase in the mobility of populations, any expansions of exports or of gross national product or of adult education can only serve to bring us sooner into the millennium."

Mishan's book, if read and understood, should go at least part of the way toward making national economic debate less polemic and more realistic. While the writing style chosen is unnecessarily elaborate and academic this reviewer is of the firm opinion that the reader will be well rewarded in terms of new and valuable economic insights.

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*The views expressed are not necessarily those of the Science Council.

Environmental Kit for Elementary School Teachers in the Ottawa Valley

By Pollution Probe, Ottawa. 1972. 56 p. + appendices. $1.25. Available from Pollution Probe, Ottawa, Carleton University, Ottawa, K1S 5B6.

Do a little, do a lot, but get involved! With the publication of this Kit, Pollution-Probe — Ottawa is taking its fight to save the valley's environment into the classroom. Hundreds of students have assisted Pollution Probe in their clean-up efforts, now they have the opportunity to understand why their role was important and how to prevent the destruction of their future world. Pollution-Probe sets an example of this by publishing their material on de-inked recycled fibre.

Not only does the kit provide thought-provoking, detailed lesson plans, but it has a virtual gold mine of helpful information which previously the teacher had difficulty in locating. They include 'Audubon Aids — Conservation Fact Sheets', Ecological puzzles, a bibliography of visual aids, poster and pamphlet sources and a general reading list.

A great deal of credit should be given to the teachers and members of Pollution Probe for developing this worthwhile kit for the junior grade levels. As they have stated in their preamble, it's 'not an attempt to provide interested teachers in the field with a complete ecological framework from which to operate. They are a series of lessons dealing with a number of key concepts related to the field of ecology' . . . This approach increases the flexibility and encompasses a wider range of disciplines and grade levels.

The lesson plans are simple to follow and appear to start with the premise that the teacher has had no previous training in the subject (a situation which often arises and for which few books make allowances). Varied lessons provide the class with a diversity of shared experiences for which the teacher can easily prepare or make arrangements. They stimulate the children through the use of all senses and present them with challenging questions. For example, Lesson #2 in Unit II begins with Charles Darwin's "The amount of beef produced in a season depends on the number of cats in the neighbourhood of the clover

field." The lesson continues to develop the concept of food chains with the children's preparation of examples of their own food chains. Reinforcement of the intricate web so formed, comes through the playing, or enacting of 'The Food Chain Game — The Web of Life'. In this activity, strings held by the students represent the interrelationships of the many members of the community. The kit leads us through the ecological 'Building Blocks' (Management of Natural Resources, Living Organisms, Soil and Field Crops) to 'Urban Living' and into the final set of lessons on 'Current Human Problems Considered in Isolation'. All of these topics are treated in an exciting, logical sequence which will enable the child to obtain a broad perspective of our environment and its problems.

The final section, the Appendix, will send teachers scurrying for pencils and paper to order pamphlets, posters and films. The lists are endowed with all the details which make the use of concrete aids a provocative, eventful addition to the lessons rather than a time-consuming, often fruitless search. They include; a synopsis of the aid or description where possible, the name of the company producing the goods, the method of distribution and approximate cost.

In general, Pollution Probe has produced a well-rounded all-inclusive kit for the teacher wishing to have a group of students equipped with ideas of how they can serve their environment now.

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Making Wildlife Movies: An Introduction

By Christopher Parsons. David and Charles Ltd., Newton Abbot, England. 1971. 224 p. £3.00.

This is a good solid book that almost covers every aspect of the making of wildlife films. Its main interest is for beginners and amateurs, but I also feel that many sections of the book are of interest to professional film makers who have not specialized in filming wildlife but want to expand their knowledge and pick up a few tricks.

The construction and use of blinds is very well covered. I also found the chapter on ethics in the filming of wildlife very interesting and of considerable importance. Ethics seem to fall into two categories. One is the question of setting up sequences, depicting one animal preying upon another. At what point does it become immoral to feed one animal to another? The other category of ethics that is extremely well covered is the question of representing truthfully the real behavior of animals. For example, confrontations and fights between different species of animals are rare, and while a film maker might be justified in including one such fight, he does start pushing credulity when the film shows three and four such confrontations. This is one thing that many well-known film makers have been guilty of doing.

While the book is principally about the filming of wildlife, all stages in the making of a film are adequately covered from scripting, through shooting, editing, sound, negative cutting and final release print. The book does not take it for granted that the film maker can afford to take off a workprint and makes helpful suggestions on how to slash costs to the minimum. The book also recognizes that the amateur is limited in time as well as resources. The writer is British and I assume he has done most of his filming in Britain, but everything he has to say is applicable to filming in Canada.

One of the few faults I find with the book is the cover. The book is, after all, a book on photography and I cannot help thinking that they could have done better. The author or someone is shown in standing position filming a pair of badgers just as anyone might do with his baby brownie. This represents the most unimaginative angle from which it is possible to film an animal. The photographs in the book are adequate but nothing to write home about. For example, there are many shots of people using cameras, blinds and various set ups but not one shot with an animal large in the foreground with the photographer in the same frame.

While I realize the book was not meant to be a picture book, I do feel that a few extremely good and obviously difficult-to-film scenes would have enhanced the book considerably and provided inspiration for the reader to get out there and start shooting. However, I would highly recommend the book for beginners and amateur film makers and also professionals who have not specialized in the filming of wildlife.

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Data Processing in Biology and Geology

By J. L. Cutbill (Ed.). Academic Press, London & New York. 1971. xv + 346 p. $15.00.

This represents the proceedings of a symposium held in September 1969 by the Systematics Association, a British based organisation (though with an international membership) devoted to "the study of systematics in relation to general biology and evolution".

In terms of content the extensive geological contribution is immediately evident comprising 13 of the 20 chapters. So far as I can tell this is not made to the exclusion of any important EDP applications in biology, suggesting that the data-processing needs of the earth scientists are currently even more pressing than those of their life scientist colleagues. Assuredly it was not for nothing that Linnaeus was more successful in classifying plants and animals than he was rocks and minerals!

The volume attempts with some success to integrate the topics covered, beginning with the problems associated with initial capture of machine-readable data, considering next the development of languages or systems for describing and manipulating these data in the computer, looking to some extent at different types of output such as graphical and visual display, and drawing to the readers' attention some of the problems and possibilities in managing the vast quantities of existing data and the far larger amounts that will shortly be produced.

There are probably three chapters of particular interest to field naturalists and environmental biologists. One is a description by Frank Perring of the British Biological Recording Network operated by the Nature Conservancy's Biological Records Centre. The magnificent *Atlas of the British Flora* (edd. Perring & Walters, 1962), showing distribution based on 10-kilometre square records and now being updated, represents the origin of this operation, which is also co-operating with the European Flora Mapping Scheme and the Invertebrate Survey of Europe. From this continent the Flora North America project is described by Shetler and others, giving full details of the pilot phase of the project which is now moving into its production stage. It represents an attempt to apply, for the first time, EDP capabilities to the storage and manipulation of systematic information; the "Flora" will be an open-ended taxon-based data bank from which, initially, hard-copy floristic reports (the conventional Flora) will be generated but to which eventually access will normally be on-line, and the precise output required specified by the user, much as to-day he selects one page in a particular book. An EDP application which has already been compared successfully with conventional methods is that described by R. J. Pankhurst and S. M. Walters of Cambridge. Their program to generate taxonomic keys by computer used the same data base as that used for the key to the genera of the Umbelliferae in *Flora Europaea*. The computer key had 20% fewer leads, used fewer characters and was line by line more compact.

Gratifyingly however the symposium is not confined to success stories and optimistic forecasts. The very real problems in data processing of incompatibilities of computer systems, and of moving from the experimental stage to routine use are considered, if not solved. This reviewer was a little disappointed, however, that one question which will be of far-reaching importance is scarcely mentioned here. This is the problem of authority. The present system of data publication in scientific journals or the production of a diversity of Floras for a single area, ensures, for the most part, that all well-reasoned data presentations can be communicated, and the user can compare these and make his own judgements. Such a facility is easily lost in a data-bank which carries out any data synthesis as a taxon-based one does by its very nature. It is usually easy to update or "correct" stored data but taxonomists, at least, know that new does not necessarily mean better, and the method of control of revisions in a national or international data bank could have far-reaching effects on the development and utilisation of that whole field of knowledge.

In the Introduction the Editor makes the very important point that automatic data processing to be really useful should not simply be used to speed up existing operations but must be made to provide new methods which take full account not only of the available technology but of why we collect and use data. This volume represents a valuable start in this process, and perhaps a future symposium might carry it further and in so doing explore some of the questions that this one does not tackle.

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The Milepost (Guide Book to the Alaska Highway)

Alaska Northwest Publishing Company, Anchorage, Alaska 99509. 24th Annual Edition, 1972. 465 p. $2.95.

This reasonably priced guide book gives up-to-date mile-by-mile description of the Alaska Highway and its connecting roads. Combined with this there are many illustrations and a series of notes about interesting historical and natural history aspects of the country through which the roads pass. There are thirty community maps as well as five road maps.

The illustrations, notes and maps are supplemented by advertising material dealing with the commercial enterprises along the roads which would be of interest to travellers. Included are advertisements for commercial establishments providing accommodation, meals and other services in wide variety. Travellers, as well as those with specialized interests in photography, hunting, fishing and other outdoor activities, can get an idea of what kinds of facilities to expect in the various areas.

The book provides an interesting and useful guide to travel in the northwest whether you are just planning a trip or are actually on the road. It is a useful supplement to other travel information on the routes covered.

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NEW TITLES

Botany

Botany: An ecological approach. Jensen, W. A., and F. B. Salisbury. Wadsworth Pub. Co., Belmont, Calif. 1972. 758 p. $13.95.

The Chemistry and Mode of Action of Herbicides. Ashton, F. M., and A. S. Crafts. Wiley-Interscience, New York. 1972.

Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada. Hotchkiss, N. Dover Publications, New York. 1972. 124 p. $3.00.

Seed Biology. Vol. 2. Germination Control, Metabolism, and Pathology. Kozlowski, T. T. (Ed.). Academic Press Inc., New York. 1972. 447 p. $26.00.

Some Common Flowering Plants of Uganda. Lind, E. M., and A. C. Tallantire. Oxford University Press, New York. 1972. 2nd ed. 260 p. $4.50.

Taxonomy, Phytogeography and Evolution. Valentine, D. H. (Ed.). Academic Press Inc., New York. 1972. 432 p. $7.20.

Water Deficits and Plant Growth. Vol. 3. Plant Responses and Control of Water Balance. Kozlowski, T. T. (Ed.). Academic Press Inc., New York. 368 p. $19.50.

Zoology

The Avian Brain. Pearson, R. P. Academic Press Inc., New York. 1972. 658 p. $31.00.

Climbing Man's Family Tree: A Collection of Major Writings on Human Phylogeny, 1969-1971. McCown, T. D., and K. A. R. Kennedy (Eds.). Prentice-Hall Inc., Englewood Cliffs, N.J. 1972. 484 p. $5.95 .

Distribution and Variation of the Catostomidae of Minnesota. Philips, G. L., and J. C. Underhill. Bell Museum of Natural History, Univ. Minnesota, Minneapolis. 1972. Occasional Paper No. 10. 45 p. $2.00.

Growth and Ecology of Fish Populations. Weatherly, A. H. Academic Press Inc., New York. 1972. 295 p. $13.50.

Jamaica and Its Butterflies. Brown, F. M., and B. Heineman. Classey, London. 1972. 478 p. $44.00. Avail. in U.S. and Canada from Entomological Reprint Specialists, Los Angeles.

Kingdom of the Seashell. Abbot, R. T. Crown Publishers, New York. 1972. 256 p. $14.95.

The Palaearctic-African Bird Migration Systems. Moreau, R. E. Academic Press Inc., New York. 1972. 386 p. £7.80.

Primate Evolution: An Introduction to Man's Place in Nature. Simons, E. L. Macmillan Co., New York, Toronto. 1972. 322 p. $5.95. Macmillan Series in Physical Anthropology.

Regional Variation in Indian Ocean Coral Reefs. Stoddart, D. R., and Sir. Maurice Yonge (Eds.). Academic Press Inc., New York and London. 1971. Symposium No. 28 of the Zoological Society of London. 584 p. $28.00.

A Simulation Model for the Management of Sandhill Cranes. Miller, R. S., G. S. Hochbaum, and D. B. Botkin. Yale Univ. School Forestry and Environmental Studies Bull. No. 80. 1972. 49 p. $2.50. Avail. 205 Prospect St., New Haven, Conn. 06511.

The Underwater World. Vevers, G. St. Martin's Press, New York. 1972. 168 p. $5.95. The interrelationship and foodchain between the varied groups, from marine plankton to life on the sea floor and the fishes of the open and deep sea form the central theme of this book.

Wildlife of Australia. Serventy, V. Taplinger Pub. Co., New York. 1972. 140 p. $9.95. The shape of the land, its mammals and marsupials, its birds, reptiles and amphibians are all described.

Environment

Conservation in the Soviet Union. Pryde, P. R. Cambridge University Press, New York. 1972. 316 p. $12.50. A survery of resource management in the USSR, examining attitudes, and accomplishments. It attempts to define the meaning of "conservation" in the USSR.

Ecology of Devastated Land. Hutnik, R. J. (Ed.). Gordon and Breach Science Publishers, London. 1973. 1200 p. Proceedings of the NATO advanced study on The Ecology and Revegetation of Drastically Disturbed Areas.

Economics of Natural and Environmental Resources. Smith, V. L. Gordon and Breach Science Publishers, London. 1973. 390 p. Characteristics of production and consumption of resources.

The Environment and Its Resources. Deju, R. A., R. B. Bhappu, G. C. Evans, and A. B. Baez. Gordon and Breach Science Publishers, London. 1973. 530 p. Deals with aspects of the environment which fall into the realm of natural science.

Environmental Mercury Contamination. Hartung, R., and B. D. Dinman (Eds.). John Wiley and Sons Ltd., New York and Toronto. 1972. 400 p. A four part, edited report of the International Conference on Mercury, held at the University of Michigan, Oct. 1970. New material has been added, as well as an edited discussion.

A Guide to Marine Pollution. Goldberg, E. D. Gordon and Breach Science Publishers, London. 1972. 180 p. £4.15. A seminar held in conjunction with the FAO Technical Conference on Marine Pollution and Its Effects on Resources and Fishing.

Must the Seas Die? Moorcraft, C. Griffin House Inc., Toronto. 1972. $3.95 paper, $8.50 cloth. Life in the seas is one of Man's vital resources. A look at our current activities which are causing it to decline at an alarming rate.

Pollution: Its Impact on Mental Health. U.S. Dept. Health, Education, Welfare Publ. No. (HMS) 72-9135. U.S. Government Printing Office, Washington, D.C. 1972. $0.45.

Your Environment: Air, Air Pollution and Weather. Henson, C. M. Interstate Printers and Publishers, Danville, Ill. 1971. 206 p. $4.95.

Canadian Titles

Canada's Water — For Sale? Bocking, Richard C. James Lewis and Samuel, Torono. 1972. 192 p. $6.95. The first comprehensive and coherent casebook on the debate over Canada's water. He challenges the myth that the U.S. needs Canada's water, and proposes a radically new water policy for Canada.

Greenpeace. Hunter, R., and R. Keziere. McClelland and Stewart, Toronto. 1972. 112 p. $3.95. Greenpeace 1 sailed into the U.S. nuclear testing grounds at Amchitka, Alaska to plead for ecological sanity. Magnificent black and white photos, and a dramatic text.

***Guide Sonore des Oiseaux du Québec.** Vol. 1. Bédard, Jean. La Societé Zoologique de Québec Inc., 8191 Ave du Zoo, Orsainville 7, P.Q. 1972. 83 $3.98 bird songs recorded from river, marsh forest, farm, and city habitats in Québec. Distributed by London Records.

How Long Have We Got? Ritchie-Calder, Lord. McGill-Queen's Univ. Press, Montreal. 1972. 88 p. $2.95. Three lectures given by Lord Ritchie-Calder at McGill. How Man has headed toward the almost irreversible position of self destruction; how we may still have the opportunity to save ourselves.

James Bay: The Plot to Drown the North Woods. Richardson, Boyce. Clarke Irwin Co., Toronto. 1972. 160 p. $2.75. A merciless indictment of the Quebec Government for the political decision to develop the vast James Bay watershed for hydro-electric power before ecological studies were completed.

***Les Oiseaux de Quebec.** Cayouette, Raymond, and Jean-Luc Grondin. La Societé Zoologique de Québec Inc., 8191 Ave. du Zoo, Orsainville 7, Que. 1972. 117 p. Black and white drawings by J.-L. Grondin of many of the birds inhabiting Quebec, along with text describing habitat and habits etc.

***Natural Resource Policy in Canada: Issues and Perspectives.** Burton, Thomas L. McClelland and Stewart, Toronto. 1972. $3.50.

Northern Realities. Lotz, Jim. New Press, Toronto. 1972. 307 p. $1.95. The future of northern development in Canada.

The Oxygen Revolution. Mains. Geoffrey. New Press, Toronto. 1972. 250 p. $6.50. The development of oxygen-dependent life from earliest times, and what we must do now to keep this life continuing.

Pollution: Economy and Environment. Victor, Peter. Univ. Toronto Press, Toronto. 1972. 270 p. $17.50. The first major analysis of the interaction between the Canadian economy and the environment which supports it.

Science Council of Canada Publications in 1972. Available from Information Canada Bookstores. Variously paged and priced.

Reports

No. 16 — It's Not Too Late Yet (A Look at Some Pollution Problems in Canada).
17 — Lifeline — Some Policies for Basic Biology in Canada.
18 — Policy Objectives for Basic Research in Canada.

Special Studies

No. 22 — Multinational Firms, Foreign Guide Investment, and Canadian Science Policy.
23 — Innovation and Structure of Canadian Industry.
24 — Air Quality — Local Regional and Global Aspects.

S.O.S. Biosphere. Rondeau, Clement H. Editions Hurtubises HMH Ltée, 380 Craig St. W., Montreal 126. 1972. 146 p. $3.00. A book about pollution written in French and for the general reader. Well written and with a good glossary.

There's a Seal in My Sleeping Bag. Hancock, Lyn. Collins Pub. Co. 1972. 292 p. $6.95. The humourous side of the first years of married life with a Canadian conservationist, David Hancock.

Watchers at the Pond. Russell, Franklin. McClelland and Stewart, Toronto. 1972. 240 p. $6.95. The unexpectedly dramatic story of the cycle of a year within the teeming universe of a pond.

Miscellaneous

Africa: A Study in Tropical Development. Stamp, L. D., and W. T. W. Morgan. John Wiley and Sons Ltd., New York. 1972. 3rd ed. 520 p. $14.95.

Arid Lands in Transition. Dregne, H. E. (Ed.). Amer. Assoc. Advan. Sci., Washington, D.C. 1972. 524 p. $15.75. Scientists from 14 countries assess the changing conditions, the potential for development and possible solutions to problems of development of arid regions in 15 countries.

Biogeography: An Ecological and Evolutionary Approach. Cox, C. B., I. N. Healy, and P. D. Moore. Blackwell Scientific Publications, Oxford. 1972. 240 p. £3.50 cloth, £2.00 paper.

Biology of Brackish Water. Remane, A, and C. Schheper. Wiley-Interscience, New York, Toronto. 1971. 2nd ed. 372 p. $21.95.

Biology and Social Behaviour. Mazur, A., and L. S. Robertson. Free Press Inc., New York. 1972. 200 p. $7.95.

Civilization and Climate. Huntington, Ellsworth. The Shoe String Press, Hamden, Conn. 1971. 3rd ed. 453 p. $15.00.

The Desert World. Costello, D. F. Thomas Y. Crowell Co., New York. 1972. 264 p. $7.95.

Ecology and Palaeoecology of Marine Environments. Schafer Wilhelm. (trans. by Irmgard Oertel, ed. by G. Y. Craig). Univ. Chicago Press, Chicago. 1972. 568 p. $25.00. This 1962 German study describes the ecology of the complete range of organisms the North Sea, their functional morphology, and ecological communities.

Epidemiology of DDT. Davies, J. E., and W. F. Edmundson (Eds.). Futura Pub. Co., Mount Kisco, N.Y. 1972. 157 p. $14.95. A collection of papers from pharmacology and epidemiology literature on DDT and its metabolites' effect on humans.

On Evolution. Smith, J. M. Edinburgh University Press, Edinburgh. 1972. 126 p. $5.50. Available in U.S. and Canada from Aldine-Atherton Co., Chicago.

A Guide to the Study of Soil Ecology. Davies, N. D., D. G. Stoker, D. E. Windson, M. T. Ashcroft, M. C. Coburn, and W. A. Andrews. Prentice-Hall Inc., Englewood Cliffs, N. J. 1972. 224 p. Eco/system relationships of the soil through lab and field work. For class or individualized study.

Hibernation and Hypothermia: Perspectives and Challenges. South, F. E., and J. P. Hannon (Eds.). American Elsevier Pub. Co., New York. 1972. 744 p. $24.50. A symposium held at Snowmass-at-Aspen, Colo. Jan. 1971.

History of Biology. Gardner, E. J. Burgess Pub. Co., Minneapolis, Minn. 1972. 3rd ed. 464 p. $9.95.

Island Year. Heckman, Hazel. Univ. Washington Press, Seattle, Wash. 1972. 256 p. $7.95.

Politics In Science. Blissett, Marlan. Little, Brown Co., Boston, Mass. 1972. 230 p. $4.25. Basic Studies in Politics series.

Populations in a Seasonal Environment. Fretwell, S. D. Princeton Univ. Press, Princeton, N.J. 1972. 218 p. $12.50 cloth, $4.95 paper. Monographs in Population Biology series.

Research for the World Food Crisis. Aldrich, D. G. (Ed.). Amer. Assoc. Advan. Sci., Washington, D.C. 1972. 320 p. $12.50. Fifteen scientists conclude that new methods will make it possible to meet the food needs of the world's rapidly increasing population throughout the 21st century.

The Stress of Hot Environments. Kerslake, D. McK. Cambridge University Press, 1972. 316 p. $19.50.

Survival in the Bush. Assiniwi, B. Copp Clark Co., Toronto. 1972. 176 p. $2.95.

Wilderness Survival. Berglund, B. Pagurian Press, Toronto. 1972. 192 p. $6.95.

*Assigned for Review

Report of Council to the Ninety-Fourth Annual Meeting of The Ottawa Field-Naturalists' Club, December 12, 1972

During the past year, twelve meetings of Council were held in the Boardroom, K. W. Neatby Building: December 8, 1971, January 10, January 17, February 21, March 20, April 17, May 29, June 19, June 26, September 11, October 2, and November 23, 1972.

Appointments for 1972 were made as follows:

Editor, The Canadian Field-Naturalist
— T. Mosquin,
after September 11 . . . Lorraine C. Smith

Business Manager, The Canadian Field-Naturalist
— W. J. Cody

Publications Committee
— J. H. Ginns (Chairman),
W. J. Cody, Anne Hanes, T. Mosquin,
G. A. Neville, O. Peck.

Excursions and Lectures Committee
— E. C. D. Todd (Chairman),
W. J. Clark, Janette Dean, R. A. Foxall,
J. Harwig, R. M. Reed, A. Sheppard.

Editorial Committee for Trail & Landscape
— Anne Hanes, Editor;
Joyce Reddoch and Lorraine Smith, Associate Editors.

Macoun Field Club Committee
— J. A. Fournier (Chairman),
I. Brodo, W. Grimm, G. Hamre,
M. Schepannek, A. Sheppard.

Research and Briefs Committee
— H. N. MacKenzie (Chairman),
G. H. McGee, Joyce Reddoch,
J. M. Robinson, G. J. Wasteneys.

F.O.N. Affairs Committee
— Elva MacKenzie (Chairman),
Vi Humphreys, Mary Stuart, A. J. Erskine.

Finance Committee
— G. J. Wasteneys (Chairman),
I. Brodo, W. J. Cody, G. R. Hanes, P. Kevan,
G. A. Neville, Joyce Reddoch, E. C. D. Todd.

Membership Committee
— Joyce Reddoch (Chairman),
Dorothy Greene, Luella Howden,
Vi Humphreys, Mary Stuart, H. A. Thomson.

Bird Records Committee
— R. A. Foxall (Chairman),
F. M. Brigham, D. Brunton, A. J. Erskine,
G. Holland, J. D. Lafontaine,
H. N. MacKenzie, R. Pittaway, B. MacTavish,
J. Woolley.

Education Committee
— I. Brodo (Chairman),
A. Bouvier, A. J. Fournier, Luella Howden,
Elva MacKenzie.

Natural Areas Committee
— D. R. Oliver (Chairman),
J. Bouvier, J. D. Lafontaine,
H. N. MacKenzie.

Publicity Committee
— J. D. Gates (Chairman),
Anne Hanes, G. H. McGee.

Report of the Publications Committee

Since the last Annual meeting, 4 numbers of The Canadian Field-Naturalist have been published. These include Volume 85, Number 4 (October-December, 1971, including 91 pages); and Volume 86, Numbers 1 (January-March, 1972, containing 122 pages), 2 (April-June, 1972, containing 83 pages), and 3 (July-September, 1972, containing 123 pages. Volume 86, Number 4 should be mailed to subscribers in December, 1972.

Of particular interest in these issues is the editorial introducing the *Canadian Nature Federation* (Vol. 85, No. 4) and a paper entitled *Research on Canadian Mammals* (Vol. 86, No. 3). The latter clearly shows the important role that this journal has played in the dissemination of research data in this field of natural history.

In July, Dr. Mosquin indicated that he wished to be replaced as Editor. His energy and devotion will be missed. However, from a group of highly qualified individuals, Dr. Lorraine Smith of Carleton University, Ottawa, was selected as the new editor.

The Conservation Committee of the Canadian National Sportsmen's Show again generously supported the publication of The Canadian Field-Naturalist, through a grant of $500. For the first time, the journal applied to the Grants and Scholarships Committee of the National Research Council and received a grant of $3,000. The latter grant was requested to a) enable expansion of the journal; b) continue financial support to authors who do not have a source of funds to cover page charges etc.; and c) offset projected increases in cost of producing The Canadian Field-Naturalist.

Expenditures for The Canadian Field-Naturalist are presented with the financial statement of the Club. A change in the presentation of the journal's finances should give the readers considerably more detail regarding sources of income and expenditures.

Report of the Excursions and Lectures Committee

During 1972, there were 50 excursions, 6 discussion groups, one formal lecture, one general meeting, one annual meeting and the annual dinner. There was an overall increase in the number of excursions over the previous year with 30

ornithological, 5 botanical, 2 geological, one entomological, one herpetological, one astronomical and 9 general interest excursions. Features of the ornithological trips were the continuation of walks specifically for beginners in the spring and fall, and also breeding bird walks in June. In addition, new this year, inventory trips were arranged in conjunction with the Natural Areas Committee to discover more of the natural history of two selected areas. The general meeting this year was devoted to the topic of Natural Areas and Land Conservation. It was felt at this meeting, that natural areas of scientific interest should be preserved for future generations and people should be encouraged to visit and enjoy them. The surveying of these areas required the support of both "experts" and "amateurs" to collect the information, and community planners should be notified of the significance of these areas.

The trend continues this year for a reduction in the number of formal lectures (1), and an increase in the number of informal discussion groups (6). Among the topics not discussed in recent years were nature photography, ecology, fossils and mosses and liverworts. The speaker at the annual dinner was Dr. E. L. Bousfield, Chief, Zoology Division, National Museum of Natural Sciences, Ottawa and a member of the club. About 130 members heard him present an illustrated talk on the topic, Exploration of the Marine Life in the Cape Horn Islands. The Macoun Club had a display of their activities at this dinner. The committee thanks all who led excursions, took part in discussions, or arranged refreshments during the last year.

Report of the Editorial Committee for Trail & Landscape

Trail & Landscape published the usual five issues in 1972. Volume Six contained 156 pages.

The Conservation Committee of the Canadian National Sportsmen's Show supported Trail & Landscape with a grant of $250.

Report of the Macoun Field Club Committee

The scholastic year of 1971-72 was, as usual, very eventful.

Work at the Bells Corners Study Area continued through the year and is now showing definite useful results. This Spring and Summer, an excellent vegetation map was prepared and a limited distribution has been made. It might be well to qualify 'useful'. Each member does not necessarily produce a significant bit of information each time he or she visits the area. What is useful, probably as much as the information produced, is that he learns more each time how to observe nature — a quality that wil last long after the published information has disappeared.

Development of the Nature Trail has also continued apace with the other studies and will ultimately result in a practical service to the community as well as providing very practical training for the members.

The field trips continued as in preceding years for the three groups. The Seniors abandoned only one trip to the Study Area last winter and that was a bitterly cold Sunday in January with a chill factor of –40° F. During the past Summer 16 Seniors and four adults spent 10 days in Algonquin Park. The stress, this year was not so much on travelling as studying a specific region. The club camped for five days at Misty Lake and explored that region intensively.

The Club met the public at least twice last year. An exhibit was prepared and staffed by members at the founding conference of the Canadian Nature Federation last Fall. During the Spring, three members prepared a slide talk of their course trip for the Ottawa Field-Naturalists.

The yearly symposium was continued this year and excellent papers were presented. The symposium concept has been demonstrated to be very effective as a teaching and learning device.

One difficult event took place during the year — the temporary move to 860 Bank St. The new quarters are, at best, acceptable; leaving the Museum has imposed a serious hardship and will have to be reversed as soon as possible.

The recipient of the Ottawa Field-Naturalists' scholarship to the Red Bay Camp was Susan Laurie. Susan reported that her stay was immensely informative and enjoyable. The Club would like to express its gratefulness to the parent club for this consideration.

During the year, 20 speakers accepted invitations to address the club. Subjects ranged from ice age mammals to bird strikes of aircraft — a remarkable performance for any association.

Membership for the year was: Juniors 31, Intermediates 25, Seniors 30. This count actually was for the month of May, and can be considered the hard-core members of the club.

A last, and rather sad note, we would like to mention a very real loss that was suffered by the Club in the death of Herb Groh — one of the co-founders of the Club.

Report of the Research and Briefs Committee

This committee was established by the Council at a meeting held on January 10, 1972. Its functions are: to prepare or arrange for the preparation of briefs on natural history and environmental subjects on behalf of the Club; to advise the Club on the advisability of becoming involved in particular issues; and to undertake or arrange for research permitting the Club to determine what position it will take on specific matters.

Three meetings were held during 1972. A Brief was prepared to present the Club's views on a proposed Marina at Ottawa Beach. The President sent this Brief to the Planning Director of Nepean Township at the end of March. A copy was later provided, on request, to the Planning Director of the Regional Municipality of Ottawa-Carleton. Initial work was undertaken by Mr. Daniel Brunton and the committee gratefully acknowledges his contribution as well as those of others who assisted.

Insufficient advance notice of at least two other matters of concern to the Club prevented the development of an appropriate submission. This highlights the need for the Club to plan ahead so that it is prepared in advance rather than being in a position of reacting on an emergency basis.

The Chairman recently prepared a letter to the Director, Plant Research Institute, Department of Agriculture. The letter outlined the Ottawa Field-Naturalists' Club's continuing concern for preservation of the Mer Bleue and described our efforts to create an awareness of its special significance in the natural history of the Ottawa district.

Report of the Federation of Ontario Naturalists Committee

This committee met twice during 1972. In order to keep the members better informed about F.O.N. activities and projects, we introduced the F.O.N. Newspage in the January/February issue of Trail & Landscape. We intend to continue to provide the membership with F.O.N. information by this means.

Report of the Finance Committee

Duties of Finance Committee

The Finance Committee shall serve in an advisory capacity to the Council on all financial matters including the investment in the Reserve Fund.

The Finance Committee was given the responsibility for producing a budget for all Club expenditures during the 1972 year. For this purpose, a meeting was held on Monday December 20, 1971. The meeting was attended by all eight members, the President as an ex officio member and Monty Brigham by special invitation. The meeting produced an exhaustive review of the finances of the Club. All factors, including an anticipated grant from N.R.C. to assist in publication of The Canadian Field-Naturalist were taken under consideration and a comprehensive budget was established. The budget provided estimates of expenditure for all committees and for other Club objectives and was subsequently presented to Council for consideration at the meeting on January 10, 1972. The Budget was approved and has been the basis of Club expenditures during the year.

Following this most time consuming and important effort there were no further meetings of the Committee. In great part, this was because matters which might have been of concern to the Finance Committee were dealt with satisfactorily by the Publications Committee.

The Reserve Fund

No action was taken during the year with respect to changes in the investment in the Reserve Fund which remains as follows:

(1) $10,700 in Canada Savings Bonds Series S24 1969/70 maturing in 1978 and yielding at maturity 8% plus compound interest on retained earned interest amounts.

(2) Thirty-five (35) shares of of Bell Telephone Common Stock
Two (2) shares of Bell Telephone Preferred
Two (2) shares of Microsystems International Limited, a company related to Bell Telephone.

Report of the Membership Committee

The duties of the Membership Committee have been expanded to include the following responsibilities:

1. processing the membership dues in cooperation with the Treasurer,
2. sending out membership renewal forms,
3. acknowledging new Members promptly,
4. maintaining and updating the list of Members,
5. providing and updating the list of Members for the Business Manager of The Canadian Field-Naturalist and for Trail & Landscape at regular intervals,
6. informing the Council of trends in membership along with any recommendations which seem appropriate, e.g. membership drives,

7. recommending to the Council candidates for Honorary Membership.

Committee members have lightened the workload of the paid assistant, Lois Cody, by performing such tasks as mailing membership cards and membership renewal forms. We have brought the membership application form up to date and have had it reprinted.

On the recommendation of the Committee, the Council has approved for Honorary Membership the following five members: Dr. W. G. Dore, Dr. L. S. Russell, Dr. J. D. Soper, Dr. W. A. Squires, and Dr. R. W. Tufts. All are longtime club members who have made outstanding contributions to the club and/or to the knowledge of Canadian natural history. It is with regret that we note the passing of two Honorary Members during 1972 — Stuart Criddle and Herbert Groh.

The membership of the club has continued to increase, this year by about 81 members. This increase in membership follows the trend of the past several years. Details may be found in the following table.

Membership	1971	1972	Change
Local, Individual	446	404	−42
Local, Family	171	208	+37
Canada	396	465	+69
U.S.A.	92	106	+14
Other	13	13	
Honorary	11	14	+3
Net increase			+81

Report of the Bird Records Committee

The Bird Records Committee replaces the former Bird Census Committee. The functions of this new committee are to co-ordinate ornithological activities within the Club (e.g. bird counts, publication of bird records) and to determine the acceptability of local rare bird reports.

Three bird counts were organized during the year. The Christmas bird count (compiled by Montgomery Brigham and Roger Foxall) was held on December 19. Seventy-one participants (the largest number ever involved in an Ottawa bird count) managed to find 70 species of birds. The species seen that had not been recorded previously on the count were Wood Duck, Harlequin Duck, Raven, Carolina Wren and Saw-whet Owl. The total number of species recorded since the counts began in 1919 is now 114.

The Spring bird count (compiled by Montgomery Brigham) was held on May 21. Fifty participants identified 180 species including a Bald Eagle, two Ruddy Ducks, a Double-crested Cormorant, six Golden-winged Warblers, two Mockingbirds and a Short-eared Owl. The Fall count (compiled by Richard Poulin) was held on September 3. Thirty-nine participants identified 184 species, the most ever recorded on a count in the Ottawa area. Unusual species or numbers included Red-necked Grebe, Redhead, Ring-necked Duck, Peregrine Falcon, 370 Golden Plovers, 30 Upland Plovers, 6 Northern Phalaropes, White-crowned Sparrow and Fox Sparrow.

Sixteen records of unusual birds were considered by the committee. Those accepted as additions to the Ottawa District bird list were Black-legged Kittiwake, Harlequin Duck, Leconte's Sparrow, Yellow-headed Blackbird and Prothonotary Warbler. Other records accepted were the first winter record of Bobolink; the first record of Prairie Warbler for the Quebec side of the area; White-eyed Vireo (first sight record for Quebec); Carolina Wren; Whimbrel; and Varied Thrush at Braeside, Ontario. Details of these records will be published in Trail & Landscape. Records that were received but not accepted were of Sabine's Gull, Franklin's Gull, European Widgeon, and other reports of Prairie Warbler and Leconte's Sparrow.

Report of the Education Committee

The committee began its affairs with a review of its terms of reference. It was decided to concentrate on providing speakers and field-trip leaders for schools, clubs, or other groups on request. Other activities were suggested, including the sponsorship of a conservation-oriented poster contest in the Ottawa schools, and the setting up of nature trails in the Ottawa area. Inquiries were made concerning both items, but no further action was taken on them immediately. The Ottawa Humane Society informed us, however, that it would be very much interested in collaborating with the Club on some sort of poster program, but pointed out the considerable effort and expense involved. Therefore, with an eye on priorities, we did not feel we should continue to pursue that project at that time.

The committee also concluded that with the Ontario Ministry of Natural Resources, the

Ottawa-Carleton Conservation Centre, and the Macoun Field Club all setting up interpretive nature trails in various parts of the city this year, it would be best to defer any activity along these lines until the additional needs of the community become clearer. In the late fall, the committee examined the new Slack Road "Pinhey Forest" trail and will make recommendations to the Ministry of Natural Resources with regard to the preparation of a trail guide for teaching purposes.

A number of requests for field-trip leaders were received and filled. We supplied four leaders for the Outdoor Learning Center in March, two nature instructors for a non-profit children's summer camp in early July, and 10 naturalists (7 of them from the Macoun Field Club's Senior Group) to serve as leaders for the National and Provincial Parks Association's "Nature Walks" around Black Lake in the Gatineau Park from 29 July until 8 October.

Only one lecture request was received, and that was before the committee began functioning in February. The request was filled, however, by some Club members. We have a list of speakers (now being up-dated and expanded) and could fill many more requests if the need arises.

As one of the committee's final endeavours, a recommendation was made to Council that the O.F.N.C. establish three prizes of $15 each in the 1973 Ottawa Regional Science Fair for "comprehension, originality, and ingenuity in a project concerning field natural history or environmental awareness".

Report of the Publicity Committee

The original twelve tentative proposals submitted by the Publicity committee last March have been pared down to the following:

We recommend one public-oriented project each year. The Ottawa Civic Hospital was approached to see if the Ottawa Field-Naturalists' Club could establish a bird feeder in front of the hospital. This is being studied by the hospital and will need approval of council. Feeders could be established at hospitals and rest homes for benefit of the patients and the public.

The establishment of a rare bird alert system was not successful on a club-wide scale. A system had been worked out in theory but upon discussion with members of the Bird Records committee it was seen that due to the number of people involved an alert system would not be feasible for general use.

Our recommendation to have a club crest was presented to council and was turned down at the time since our club car decal has not been in demand.

Our recommendation to start a drive to push the use of car decals is in progress. The next available issue of Trail & Landscape (Mar.-Apr.) will contain an article concerning this.

Our recommendation to the Excursions and Lectures committee that (a) one OFNC excursion be planned annually whereby members could participate in a FON outing; and that (b) at least two excursions be planned involving OFNC and the Macoun Field Club to improve liaison between junior and senior clubs, was too late for consideration by that committee since their Summer schedule had been made up when we approached them in April. This recommendation may be considered for 1973.

The Pine Grove Picnic Site is now well established as reported in the Nov.-Dec. Trail & Landscape. A dressed-up display is being established here with information about the OFNC and membership forms following our recommendation to promote nature trails displays. At the moment we are watching to see how far Lands & Forests and the NCC will go in preparing the New York Central right-of-way for a walkway before proceeding in that direction.

Our committee recommends that press releases be sent from time to time to inform the public concerning the work we are undertaking. Other nature clubs are using the media to promote their events but we are not using the media in any way.

We recommend that the Membership committee give membership applications to council members and excursion leaders.

A cassette tape and record library has been established upon the donation of records and cassette tapes. The FON has been contacted for permission to use single copy cassette tapes of their recordings. The recorded items will be listed in the Mar.-Apr. Trail & Landscape.

Report of the Natural Areas Committee

The Natural Areas Committee continued to compile natural history data on the Mer Bleue and initiated studies on the Carp Hills and on an area near Manion Corners. An inventory walk was held at each of the last two areas. A brief was prepared in support of preserving the Ottawa Beach Area. Members of the Natural Areas Committee presented brief talks on the activity of the committee at the fall meeting.

Minutes of the Ninety-Third Annual Meeting of The Ottawa Field-Naturalists' Club

The 93rd annual meeting of The Ottawa Field-Naturalists' Club was held in the auditorium of the National Research Council on Sussex Drive on Thursday, December 2, 1971. The meeting was called to order at 8:05 p.m. by the President, Mrs. Sheila Thomson. Fifty-six persons were present.

The Secretary read the minutes of the 92nd annual meeting and moved that they be adopted. Harry Thomson seconded the motion and it carried. The President commented that Council had sent letters out on the four resolutions mentioned in the minutes and that some of the requests had been granted.

The Statement of Financial Standing was presented by the Treasurer, Mr. F. M. Brigham. Its adoption was moved by Mr. Brigham, seconded by Mr. W. J. Cody and carried. The President mentioned that Mr. Brigham would not be serving as Treasurer next year and commended him for his efforts on behalf of the Club.

The President reviewed the annual report, a copy of which was distributed to those present. Among the highlights mentioned were: the fact that *The Canadian Field-Naturalist* was back on schedule with 4 issues actually issued in 1971; the 44 excursions arranged by the Excursions and Lectures Committee; the success of *Trail & Landscape;* the wilderness trip arranged by the Macoun Field Club; the inventory form of the Natural Areas Committee; the success of the arrangements made by the F.O.N. Committee for the annual meeting; the warning of the Finance Committee that our expenditures are exceeding our income; the new Honorary Members and the several "firsts" of the Bird Census Committee. The Secretary moved that the annual report be accepted. Miss Luella Howden seconded the motion and it carried.

The President asked for any discussion about the annual report. Dr. George Neville asked if any request had been made for a grant from the National Research Council to publish *The Canadian Field-Naturalist.* He said that the National Research Council gave grants to several other publications. Requests are usually made in December and the grants made the following April. Mrs. Thomson promised to bring the matter to the attention of Council for consideration.

Dr. Ewen Todd presented the list of officers and council members for election. Dr. O. J. Peck moved that the name of Mr. J. M. Robinson be added to the list; Mary Stuart seconded the motion and it carried. The slate was declared elected.

Mrs. Thomson paid tribute to Dr. Mosquin who had to retire as president to take up the post of president of the Canadian Nature Federation. Among his accomplishments were: the revision of the constitution; *Trail & Landscape;* the redesigned format of *The Canadian Field-Naturalist* and the organization of the Canadian Nature Federation. Mrs. Thomson also paid tribute to the work of Mr. W. J. Cody, our business manager and the committee headed by Dr. O. J. Peck and Arnett Sheppard for the work done for the founding meeting of the Canadian Nature Federation.

It was moved by W. J. Cody seconded by H. N. MacKenzie that Geoffrey Wasteneys and Tony Erskine serve as auditors for 1972. The motion carried. Mr. Wasteneys presented the auditors' report for 1971 and reminded the meeting of the excess of expenditure over income indicating the need for an early review of our fee structure.

Dr. G. Neville referring to the report of the Finance Committee asked if we should not sell our common shares and invest in some other sort of bond in view of the withdrawal from sale of the current issue of Canada Savings Bonds. Mrs. L. C. Smith wondered if we should sell our common shares to pay our debts. Mr. Wasteneys said that this was not a good time to sell our common shares — nobody was hounding us for money and that we would actually be selling at a loss if we sold now. He recommended that we sell when the market rises. Mr. Cody said that our subscription money would soon be coming in and that we would then be "solvent" at least until later in the year.

Dr. Roger Foxall mentioned the proposed park in Nepean Township from Rocky Point to Britannia Pier on the Ottawa River. He said that this was the second most important area for birds in the region (next to Shirleys Bay) and if it were filled in it would ruin it for shore birds and puddle ducks. He urged Council to look into it and to act if work is to start immediately. He thought the property was owned by the N.C.C.

There was some discussion about the Club purchasing property. A site in Lanark County was mentioned, but no firm course of action was decided on. Mr. H. N. MacKenzie said that many Clubs are hesitant about buying land. He mentioned that the F.O.N. held a seminar over a year ago and that a pamphlet outlining procedures and

pitfalls was expected. Mrs. L. C. Smith suggested that a special fund be established to buy land as the F.O.N. has done. Mr. Ashdown mentioned that if we had a fund we could hold an annual fund raising campaign and approach the Federal Government for donations.

There was discussion about the date of the annual business meeting. It was moved by Mr. M. Brigham, seconded by Mr. G. Wasteneys that our financial year should end on December 31st in each year and that the annual meeting be held in January. The motion carried. (It should be noted that under the proposed new constitution the date of the annual business meeting is January).

Mr. G. McGee acknowledged receipt of $9.00 for the bird feeders on Moodie Drive and on the 6th line in the east end.

It was announced that the first meeting of the new Council would be held on December 8, 1971 in the National Library.

Dr. E. C. D. Todd moved that a vote of thanks be extended to Mrs. S. Thomson for her leadership. The motion carried unanimously.

At the conclusion of the business meeting the film "Atonement" was shown.

The meeting adjourned at 11:00 p.m.

A. W. RATHWELL
Secretary.

The Canadian Field-Naturalist Statement of Income and Expenditures

for the year ended November 30th, 1972

Income			
Subscriptions and Affiliations		$ 4,992.69	
Memberships (40% of Gross Memberships)		2,789.00	
Back numbers		2,237.40	
Reprints		2,537.70	
Plates and tabular settings		2,222.08	
Extra pages		2,210.53	$16,989.40
Less Expenditures			
Printing Costs		$10,747.20	
Circulating Costs		575.26	
Editing expenses including honoraria		300.61	
Reprint Costs	$3,033.94		
Geologies previously shown as inventory	1,409.00	4,442.94	
Plates and tabular settings		1,701.51	
Extra Pages		1,751.75	
Business Manager's Expense — Honorarium	$ 100.00		
— Postage	376.68		
— Salaries, etc.	1,026.76	1,503.44	21,022.71
Loss on Operations			$ 4,033.31
Less Grants			
National Research Council		$ 3,000.00	
Canadian Sportsmen's Show		500.00	3,500.00
Net Loss			$ 533.31

The Ottawa Field-Naturalists' Club Statement of Income and Expenditures

for the year ended November 30th, 1972

Income			
Memberships (60% of Gross Memberships)		$ 4,191.00	
Subscriptions (Trail & Landscape)		139.00	
Reprints (Trail & Landscape)		51.24	
Back Numbers (Trail & Landscape)		22.60	$ 4,403.84
Less Expenditures			
Bank Charges and Interest		$ 18.41	
Committee Expenses — Excursions and Lectures	$ 63.01		
— Macoun Field Club	48.80		
— Bird Feeder	186.03		
— Bird Census	56.84	354.68	
Red Bay Camp		115.00	
Orchid Survey		22.88	
Donation		100.00	
Council Operating Expenses		179.10	
General Expenses		726.86	
Postage		237.35	
Trail & Landscape — Printing Costs	$1,414.41		
— Circulating	196.03		
— Operations and Honorarium	134.68	1,745.12	
Depreciation Expense		84.72	3,584.12
Net Income on Operations			$ 819.72
Add Other Income: Interest Income	$1,240.54		
Donations	25.00		
Grant from The Canadian National Sportsmen's Show	250.00	$ 1,515.54	
Less Loss on The Canadian Field-Naturalist		533.31	982.23
Net Income			$ 1,801.95

The Ottawa Field-Naturalists' Club Balance Sheet

as at November 30th, 1972

Assets

Current			
Cash in Bank and on Hand		$ 5,866.56	
Bills Receivable		2,033.45	
Interest Income Receivable		2,808.71	$10,708.72
Fixed (at cost)			
Furniture, Fixture and Equipment		$ 529.50	
Less Accumulated Depreciation		190.62	338.88
Investments and Securities			
Bell Telephone Company of Canada			
35 Common Shares (Market Value, $1,575.00)	$1,617.20		
2 Preferred Shares (Market Value, $102.00)	94.00		
Microsystems International (Market Value, $20.00)	20.00	1,731.20	
Canada Savings Bonds		10,700.00	12,431.20
			$23,478.80

Liabilities and Equity of Surplus or Deficit

Current Liabilities			
Income Received in Advance		$ 2,720.10	
Accounts Payable		4,704.30	7,424.40
Equity of Surplus or Deficit			
Balance, December 1st, 1971		$14,252.45	
Add Net Income for the Year		1,801.95	16,054.40
			$23,478.80

(Signed) Geoffrey Wasteneys (Auditor)
F. M. Brigham (Auditor)
A. J. Erskine (Treasurer)

Instructions to Contributors

Manuscripts

Authors should submit two complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring 8½ x 11 inches, and if possible, the paper should have numbered lines. Margins should be 1 to 1½ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

An abstract is required for all Articles but is optional for Notes. Authors are requested to use at least one given name. Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text, except in Letters to the Editor. If only one or two references are cited, they should be inserted in the text. The tables should be titled and numbered consecutively in arabic numerals, and each should be placed on a separate page after the Literature Cited. Captions for figures should be typed together on one page. The places in the text for tables and figures should be marked in the margin.

The **Council of Biology Editors Style Manual,** 3rd edition (1972) published by the American Institute of Biological Sciences is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be determined by the Editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted with minimal space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $25.00 for each page in excess of six journal pages. Page charges are separate from charges for illustrations and tables.

Illustrations cost $5.00 each for any size (up to a full page). Tables cost up to $25.00 per page, depending upon size. The special charges for illustrations and tables are *in addition to* all charges that are levied for pages in excess of six.

Reviewing Policy of The Canadian Field-Naturalist

Articles and Notes offered for publication to The Canadian Field-Naturalist are normally sent to an Associate Editor and at least one other reviewer. Certain Articles receive the benefit of three or four reviews. Short Notes are reviewed by Associate Editors or qualified referees selected by them.

Reprints

Reprints with or without covers may be purchased. All reprint orders should be sent to the Business Manager, Box 3264 Postal Station 'C', Ottawa, Canada K1Y 4J5, as soon as possible after receipt of the galley and reprint order form. Members in good standing making personal purchases may request a 10% reduction in reprint costs.

Schedule of charges for reprints

Number of Reprints	1 to 4 journal pages	5 to 8 journal pages	9 to 12 journal pages	13 to 16 journal pages	17 to 20 journal pages	Additional charge for Mayfair covers
100	16.00	21.00	32.00	43.00	54.00	15.00
200	20.00	27.00	40.00	53.00	66.00	22.00
300	24.00	33.00	48.00	63.00	78.00	29.00
400	28.00	39.00	56.00	73.00	90.00	36.00
500	32.00	47.00	64.00	83.00	102.00	43.00

Affiliated Societies

Edmonton Bird Club

President, MRS. A. TAYLOR; *Honorary President,* MR. R. LISTER; *Vice-President,* MR. L. BOGAERT; *Treasurer,* MR. P. H. THOMPSON; *Field Secretary,* DR. R. W. TURNER; *Secretary,* MRS. O. YOUNG, 139 Laurier Drive, Edmonton, Alberta; *Librarian,* MR. M. HENNIE, P.O. Box 4441, Edmonton, Alberta, T6E 4T5.

Calgary Field-Naturalists' Society

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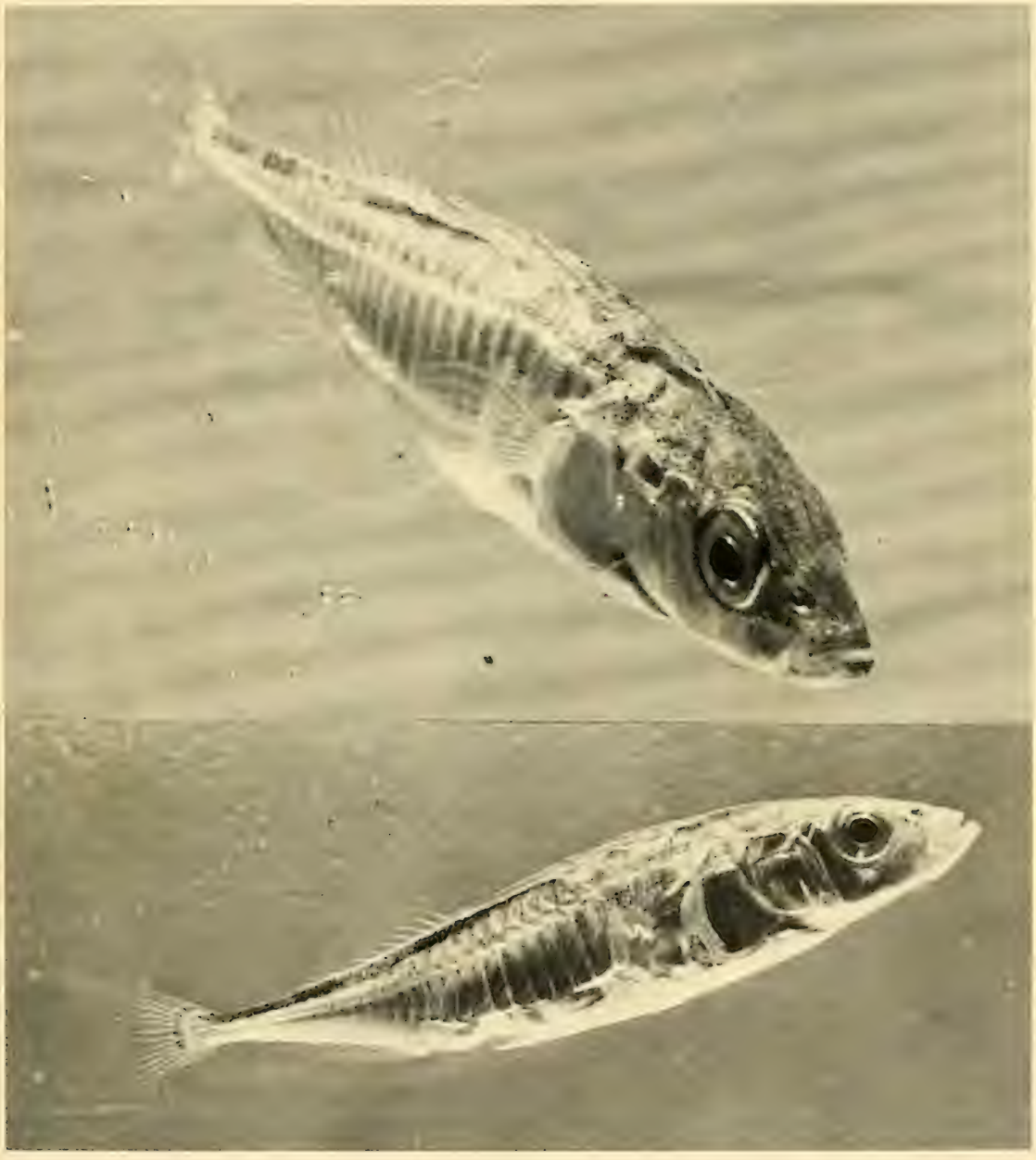

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Cover photograph: Threespine sticklebacks taken especially for this issue by Mary Primrose by courtesy of E. T. Garside, Dalhousie University. See article page 113 and note page 173.

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The United Nations and the Planetary Ecosystem

PAUL K. ANDERSON

University of Calgary, Alberta,

I would like to state clearly at the outset that my evaluation of the United Nations' Conference on the Human Environment is made in the context of a radical and strongly held opinion. The opinion is that the sustainable carrying capacity of this planet for man (even if we perpetuate the current gross inequalities) is fewer than three billion persons.

Not all ecologists feel as I do, but the occurrence of such views among ecologists may account, in large part, for their conspicuous absence in the planning and execution of the Stockholm Conference. Questions regarding the ultimate limits of resources, of economic growth, and population, are profoundly disturbing. This is particularly true with respect to the developing nations where there is a not ungrounded fear that environmental concerns may be exploited in the selfish interests of the rich and technologically developed.

To understand the Conference, we should realize that the event itself was less important than the preparations which preceded it. It was in these preparations that the issue of the limitation of the biosphere, and the population issue, were carefully orchestrated out in favour of emphasis on solutions to the gross inequities of current economic and industrial development. The process was set in motion early. The preparatory committees that produced the documents and proposals for discussion and ratification at Stockholm were staffed by economists, bankers, development specialists, and politicians of various sorts. These were experts in certain restricted, though not insignificant, parts of the total human environment, but they were untrained and incompetent where the structure, function, and resilience of the planetary ecosystem were to be examined. To put it bluntly, the Conference was a creature of the world establishment, born and raised in ignorance, if not in error, as to ecological fact and theory. It was assumed without question that there was ecological space in which to manoeuvre. It was also assumed that technology was indefinitely capable of compensating for resource shortages, and for tendencies of the world ecosystem towards collapse.

Though I start with this assessment, I can still find much that is positive in the results of the Stockholm Conference. The output falls into three categories. The first was a statement of principles, the second an action plan, and the third a proposed organization for the implementation of the first two.

The statement of principles was entitled, "Declaration on the Human Environment". Twenty-six points were listed. The first refers to human dignity and freedom, and denigrates racial prejudice, apartheid, and colonialism (social evils in the environment). Two refer to preservation of wildlife and "samples" of "natural" ecosystems (2 and 4). Three refer to renewable and non-renewable resources (3, 5, and 21). The latter are to be used wisely and shared, with the caveat (21) that sovereign nations can do as they damn well please with their resources, providing they don't pollute anyone else while they do it. Four deal with pollution: of ecosystems (6), of seas (7), control through international law (22), and with respect to the planning of human settlements (15).

No fewer than ten of the principles deal with economic and industrial development. Economic development is needed (8) and must be accelerated (9). An economic environment favourable for development must be created (10) and steps should be taken to see that the costs of making such development compatible

with environmental protection are not onerous from the point of view of the developing countries (11). Environmental concerns should not be allowed to interfere with development (12). Planning can reconcile development with environment (14) and should see to it that development is compatible with environmental quality (13). Science and technology should be applied to environmental questions as part of their contribution to development (18), scientific research should be encouraged at minimal cost to the developing countries (20) and no environmental standards should be imposed which would be inappropriate for such developing countries (23).

The matter of development having been disposed of, five topics are covered by a single principle each. Nations are advised to set up appropriate administrative institutions for dealing with the environment (17). Environmental education should be expanded (19). Weapons of mass destruction should be eliminated (26) and nations should see that international organizations do a good job with respect to the environment (25). Item 24 states bluntly that concerns about pollution shall not be allowed to interfere with the exercise of national sovereignty.

One principle (16) does deal with population. It advocates demographic planning (as long as it does not infringe either on individual rights or national sovereignty) where the rate of growth is *inadequate* or *excessive*. Neither stabilization nor reduction of populations is considered.

The Action Plan has six sections dealing, respectively, with human settlements management, natural resources management, general pollution, marine pollution, educational and social aspects, and developing nations. There are 109 points in all.

Items 1 through 18 are under the heading of Human Settlements Management. They deal with the encouragement of cooperation in the planning and improvement of human settlements, the exchange of experts and information, and the centralization and coordination of the United Nations' activities. There are sections on funding, disaster warning and relief, and the amelioration of the problems of malnutrition, noise, and the development of squatter slums.

Items 11 and 12 in this section are the only recommendations in the Action Plan referring specifically to the question of population. Item 11 directs that the preparations for the 1974 World Population Conference include attention to the relationship of population to environment. Item 12 recommends assistance by U.N. agencies to governments requesting aid in the area of family planning, and advocates research "in the field of human reproduction" in order to prevent "the serious consequences of population explosion". I thought it significant that it was "consequences" rather than "explosion" that were to be prevented.

It should be recognized that many of the recommendations under this section will, inevitably, tend to increase the utilization of resources and the extension of public health measures. The objective is to continue and expand the public health revolution. It is the spread of effective public health programs that has dropped death rates drastically and has been primarily responsible for the phenomenal growth of population following World War II. I do not mean to impy here that we should forego efforts to prevent premature death and human suffering but I think it is important that we recognize the full consequences of these efforts.

The Section on National Resources Management encompasses recommendations 19 through 69. The first ten recommendations concentrate on land use in rural areas, agricultural technology, livestock development, and the management of forested lands. The approach throughout these ten recommendations is basically exploitive, tending to increase the human impact on the environment by directing the maximal amount of biological productivity to human use. Minimization of any negative side effects comes as a pious afterthought. This is especially true with respect to forested lands in which the thrust of the recommendations seems to involve the kind of monoculture approach which dominates modern agriculture.

The management of non-human animal life forms is introduced in recommendations 29 (the use of animals as adjuncts to environmental monitoring) and 30 (the assessment of the economic value of wildlife). Recommendation 31 deals with the training of technicians in wildlife "management" (for which I read, "rational exploitation"). Appropriately, attention is given to those species which inhabit international waters and which migrate across international boundaries. Item 33 is one which should receive particular attention from Canadians. This item asked all governments concerned to implement a ten-year moratorium on commercial whaling. Canada voted in favour of this recommendation at the United Nations Conference and has recently moved to close down whaling based on Canadian shores. Canada, however, is a member of the International Whaling Commission. In the meeting of that Commission, following the Stockholm Conference, the Canadian Government representative abstained from voting and thus contributed significantly to blocking the moratorium proposed at Stockholm. Canadians should investigate the apparent duplicity of the Canadian Government in this tragic situation and take strong action (see Searle, G. 1972. Telling Whoppers. Ecologist 2(10): 12-13).

The most extensively developed section under the resource management heading deals with the conservation of "genetic resources" including both "static" resources (seed and gamete banks) and "dynamic" situations (evolving natural communities). The approach is that of a treatment of symptoms (impending decrease in genetic diversity, or extinction of species) rather than search for a cure (control of the competitive impact of human populations growing in the finite planetary ecosystem). Symptomatic treatment is better than nothing, but stores of seeds, gamete banks, and small "natural reserves" set up to maintain genetic resources are poor substitutes for a planetary ecosystem in dynamic and self-sustaining balance. The emphasis throughout this section is on species of agricultural, silvicultural, or medicinal value.

The Action Plan turns next to living marine resources. It deals with fisheries, the laws of the sea, preservation of estuarine breeding grounds of commercial fish stocks, and monitoring of marine fisheries and fish populations. The last area of concern is well taken, yet it is difficult to be optimistic in view of the long and disastrous history of over-exploitation of fish stocks, and the deplorable record of the one major precedent at international control (the International Whaling Commission).

Water management is covered by recommendations 51-55. It is suggested that provision be made for commissions to deal with the management of international river basins, general problems of water use and quality, and the environmental effects of major water management projects.

Items 56-58 are concerned with the effects of extraction and use of fuel and non-fuel minerals. Item 59 deals with the development of energy resources. Energy use is probably the best single measure of the total human impact on the biosphere. The drive of the Action Plan is towards increased availability of energy for human use and therefore towards an increasing human impact on the environment. Appropriately, but probably not intentionally, this item is followed by recommendations which advocate *prior* environmental impact studies in association with the use and development of resources (Items 60-64).

The resources section of the Action Plan concludes with reference to the Man and the Biosphere Programme, meteorological implications of resource development, remote sensing, aid to governments in resource planning, and the stabilization of marginal lands.

The section on General Pollution (recommendations 70-85) begins with advocacy of governmental concern with the effects of human activities on climate. It goes on to recommend that governments use the "best practicable" means of minimizing release of toxic substances, "unless their use is essential to human health or food production." Specific mention is made of heavy metals and organochlorine compounds. The remaining recommendations

promote governmental cooperation in establishing international standards, assessing pollutant sources, pathways and risks, and developing international mechanisms and disseminating technologies for dealing with pollution. The most significant recommendations in this section are those dealing with the establishment of a worldwide monitoring network including remote base-line stations, and others in densely inhabited areas (operation "Earthwatch").

The area of Marine Pollution is especially attractive and appropriate as regards the United Nations since it is concerned particularly with international waters. Recommendations refer to restriction and elimination of ocean dumping, as well as the control of land-based sources of marine pollution. There are very useful suggestions for the compilation of worldwide statistics on the production of potential pollutants of the marine environment. Other sections deal with monitoring, information exchange, rights and responsibilities of coastal states, availability of advice and technological assistance, and training of competent personnel.

The seven recommendations grouped under the heading of Educational, Informational, Social and Cultural Aspects relate to assistance in establishment of monitoring programmes, reporting of such programmes, the development of social and cultural indicators of environmental quality, programmes of education, and the development of citizen and non-governmental participation in environmental affairs. It is in this area of education and publicity that the Conference itself was particularly disappointing to me. My impression was that the media found the Conference of relatively little interest and perhaps anticlimactic. The book by Barbara Ward and Réne Dubos*, which was to serve as the "position statement" for the Conference, was delayed in publication and has been poorly distributed. Here in Canada it is available in hard cover, and was only briefly available in paperback (currently unavailable owing to some kind of squabble over distribution rights). It has only recently become available in the United States and these delays will seriously diminish its impact there and elsewhere.

The final recommendations in this section deal with World Environment Day and with support for various conventions such as the UNESCO Convention on the Protection of the World Natural and Cultural Heritage and the Convention on Conservation of Wetlands of International Importance. The final paragraphs instruct the Secretary-General of the United Nations to keep himself informed on environmental affairs and recommend the establishment of a reference service for environmental information.

The first of the recommendations under the heading, Development and Environment should be required reading for all environmentalists in the developed world. Its emphasis on the training of personnel to incorporate environmental concerns into developmental planning and on promoting within the developing countries the technical and administrative competence for indentifying and dealing with environmental problems reflects deficiencies which we in more fortunate lands tend to ignore. If we encounter frustration in dealing with the effluent in Sudbury, Trail, Calgary, Vancouver, or Toronto, given all the technology and riches at our command, how much more difficult must it be to get action in Korea or Brazil?

I am somewhat less sympathetic with recommendations 103 and 104. These deal with the economic interests of the developing nations in relation to environmental concerns. I do not doubt that there are good grounds for the fear that environmental concerns may be used, "as a pretext for discriminatory trade policies". If this were the total extent of the matter, these recommendations could be wholeheartedly endorsed. On the other side of the coin, however, it seems to me that the developed countries would be fully justified in utilizing trade restrictions as a means of preventing the use of chlorinated hydrocarbons to such an extent that species now endangered by past mistakes should be exterminated because these mistakes are perpetuated, or that even

*Reviewed on page 202.

more serious consequences to the planetary ecosystem as a whole should result. Future environmental insults cannot be justified on the grounds that others have made mistakes in the past. This is not, however, to argue that the rich nations of the world do not have obligations to provide material aid to their less fortunate brothers in the interest of avoiding damage to the common environment.

The final three recommendations enjoin the developed nations to examine the potential for substitution of natural products from the developing lands for polluting high-technology alternatives, to find ways of making environmentally "good" technologies available at low cost, and to continue their development aid, undiminished by environmental concerns, through the second Development Decade.

The last major task of the Stockholm Conference was agreement on an organization to promulgate the Action Plan on the basis of the Principles that were enunciated. This organization will be headquartered at Nairobi and has three components. The first is the Governing Council for Environmental Programmes. Its tasks are to develop the proposals of the Action Plan both within and outside the United Nations system. The task spelled out in most detail is "to maintain under continual review the impact of national and international environmental policies and measures on developing countries". The objective is "to ensure that such programmes and projects shall be compatible *with the development plans and priorities of those countries*" (italics mine). Neither the Governing Council, nor its executive (the Environment Secretariat) is charged with the converse, seeing to it that policies for economic growth and development are compatible with the maintenance of environmental quality and of a self-sustaining world ecosystem!

Provision is made for the establishment of a Secretariat headed by an Executive-Director and operating under the guidance of the Governing Council. One of the major duties of the Secretariat is the maintenance of an Environment Fund to be established by voluntary contributions of member nations, and to be used to finance environmental programmes within the United Nations and in the developing countries. The final organization unit is called the Environmental Coordinating Board to be chaired by the Executive-Director (Canada's Maurice Strong) and to provide coordination among the multiplicity of organizations and programmes which are involved in or affected by the Action Plan.

My conclusion is that one must recognize that the Stockholm Conference was a political rather than a scientific effort. Its main contributions are political, and for many of these we should be grateful. In part, it was what I think of as ecological pornography, a skillfully engineered effort to exploit environmental concerns for other ends. In this case I find these ends laudable, (strengthening of the United Nations and supporting the desperate battle of the third world for economic development). However, I believe that emphasis on these goals prevented any true assessment of the total relationship, present and future, of man and the world ecosystem of which he is a part and by which he is supported. The conference operated throughout on the undemonstrated premise that continuing function of that ecosystem is compatible with indefinitely continued economic growth.

Despite such disabilities, there were many extremely important accomplishments. Foundations were laid for an enormous range of environmental assessments and a worldwide monitoring network. The chauvinistic and self-righteous attitudes of the rich nations received a much-needed jolt. The importance of technical aid and assistance, and the avenues by which these could be developed, were spotlighted. The basis was laid for a United Nations organization in the area of environment which may grow in wisdom and effectiveness, despite its limited and unbalanced origins.

Could the positive accomplishments of the Stockholm Conference have been achieved without shutting the door on consideration of the basic issue of the earth's carrying capacity

for man? Maurice Strong and the other "realists" in the field of international politics said "No". Subordinating ecological realities to political realities was an *uncalculated* risk taken by men innocent of ecological knowledge but expert in politics. Ecologists, equally unsophisticated in political realities, can only wonder whether the approach was necessary, and whether the cost of avoiding the issue was justified. At any rate, the stage is set for a second Conference at some unspecified time in the future and there may perhaps then be opportunity for an effective and more truly ecological assessment of "The Human Environment".

Observations on the Ecology and Phenotypic Variation of the Threespine Stickleback, *Gasterosteus aculeatus* L., 1758, and the Blackspotted Stickleback, *G. wheatlandi* Putnam, 1867, (Osteichthyes: Gasterosteidae) in Amory Cove, Québec[1]

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Coad, B. W. and G. Power. 1973. Observations on the ecology and phenotypic variation of the threespine stickleback, *Gasterosteus aculeatus* L., 1758, and the blackspotted stickleback, *G. wheatlandi* Putnam, 1867, (Osteichthyes:Gasterosteidae) in Amory Cove, Québec. Canadian Field-Naturalist 87: 113-122.

Abstract. Sympatric populations of the threespine stickleback, *Gasterosteus aculeatus,* and the blackspotted stickleback, *G. wheatlandi* in Amory Cove, Québec were examined for variation in phenotype and ecology. There were marked differences in lateral plate, vertebrae, gill raker, and anal and dorsal soft ray number, these characters having higher counts in *G. aculeatus.* Spine morphology, body depth and breeding color were also different in the two species. The life span of *G. wheatlandi* was 1 year and some months, while *G. aculeatus* lived for 2 years and some months and spawned in the third year of life. One-year-old *G. aculeatus* were rarely found in the littoral area. Spawning occurred during May and June and possibly July. Mature *G. aculeatus,* which were larger on average than *G. wheatlandi,* produced more and larger eggs. An account of the temperature and salinity fluctuation in the tidal pools during the breeding season is given and it is suggested that the pools provided an area with suitable temperature conditions and fewer predators than the sea.

Introduction

The genus *Gasterosteus* Linnaeus 1758 contains two recognized species, *G. aculeatus* L., 1758, the threespine stickleback, and *G. wheatlandi* Putnam, 1867, the blackspotted stickleback, which may be found in marine littoral areas of eastern North America. The former species is amphiboreal while the latter is limited in its distribution to the Atlantic coast of North America from the northern tip of Newfoundland (Van Vliet 1970) south to Long Island, New York (Perlmutter 1963).

Populations of *G. aculeatus* have been studied extensively in Europe (e.g. Bertin 1925; Heuts 1947; Jones and Hynes 1950; Munzing 1959, 1963; Penczak 1965, 1966), and more recently on the Pacific coast of North America (e.g. Greenbank and Nelson 1959; Hagen 1967; Narver 1969, but comparatively little is known about western Atlantic populations. Apart from the studies of McInerney (1969) and Reisman (1968) on reproduction, little is known about the biology of *G. wheatlandi,* possibly owing to some confusion with *G. aculeatus.* It is nevertheless readily distinguishable from marine *G. aculeatus* by the lack of a caudal keel, a low lateral plate count and the presence of two soft rays in the pelvic fin, in addition to other characters referred to later in the discussion (Hubbs 1929).

Sympatric populations of these two species were found in 1971 in Amory Cove (50°17′ N, 65°57′ W) on the north shore of the Gulf of St. Lawrence 33 km east of Sept Illes, Québec. Some 700 specimens were examined in a study of their ecology and phenotypic variation.

Materials and Methods

Collections were made by dip-netting individuals from tidal pools during May, June, and July, 1971. Young-of-the-year of *G. aculeatus* were collected during August, 1970. All specimens were preserved in 70% ethanol.

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Formalin was avoided because it damages otoliths used in age determination.

Length from snout to hypural fold was recorded to the nearest millimeter (standard length). Conversion factors for total length were 1.15 for *G. aculeatus,* 20–73 mm, and 1.20 for *G. wheatlandi,* 27–38 mm (N = 100 in both species). Body depth, caudal peduncle length, and head length excluding the opercular membrane, were measured to the nearest half millimeter using dial calipers, according to the methods of Hubbs and Lagler (1958) (N = 50 in both species). These measurements were expressed as thousandths of standard length.

Otoliths were used for age determination according to the method of Jones and Hynes (1950). Wherever possible both sagittae from each fish were mounted in Canada balsam or euparol, and both were read. No disagreement was found between any of the otolith pairs.

Detailed food analyses were not carried out but the stomachs of 50 specimens of each species were examined for food items.

Sex and maturity were determined by examination of the reproductive organs under a dissecting microscope. Total egg counts were made on each ovary of females judged to be at maturity stage IV or V (after Nikolsky 1963) and the average diameter of 20 unfertilized eggs chosen at random from each female was estimated using a calibrated micrometer eyepiece.

Daytime temperatures and salinities were measured at first daily, later every fourth day, in six tidal pools and at the surface of Amory Cove from 25 May until 12 July, 1971. Precipitation and sunshine were obtained from the Monthly Meteorological Summary of Sept Iles airport.

The number of dorsal, anal, caudal, pectoral, and pelvic fin rays was noted in samples of each species and a distinction was drawn between spines and soft rays. Hubbs and Lagler (1958) state that it is the general custom to count the last two fin ray bases of the dorsal and anal fin as one ray. This practice was not adhered to in this study since the last two rays in either fin were readily distinguishable. The number of scutes or lateral plates on the left flank of each fish was counted, including those contributing to the caudal keel in *G. aculeatus.* The gill rakers on the entire left first arch were counted and rudimentary rakers were included. The number of vertebrae was determined by microscopic examination of X-ray plates (Kodak Industrial Type M) exposed in a soft X-ray machine (Softex Type EMB) at 20 KV and 8 mA for 8 seconds. The hypural plate was counted as one vertebra.

The length of the first dorsal spine in 0+ and 2+ age group *G. aculeatus* was measured from the base to the tip of the spine proper, exclusive of any fleshy extensions. Body depth was measured below the first dorsal spine.

Results

Area Description

Amory Cove is a shallow area approximately 1 km long by 550 m wide with a large island in the center. The sides of the Cove and the island have a variety of rock pools exposed at low tide. The size of these vary with the tide and with evaporation while exposed. The largest is about 8 m by 2 m. The Cove is never completely drained at low tide but fewer sticklebacks were encountered than could be found in the tidal pools, except during migrations to and from the sea. The bottom of the pools vary from sand and rock to a sand–mud mixture interspersed with debris brought in on the tides. The plant community is dominated by the algae *Ectocarpus* sp. and *Cladophora* sp., which developed rapidly in mid-June. Small clumps of *Pelvetia* sp. also began to develop at this time. Many diatoms and several species of blue-green algae were also present.

Only two other species of fish were commonly encountered in Amory Cove, namely *Pseudopleuronectes americanus* (Walbaum, 1792), the winter flounder, and *Myoxocephalus scorpius* (L., 1758), the shorthorn sculpin.

Age

Members of the *G. wheatlandi* population appeared to live for 1–2 years. Only one age group was caught (1+). Individuals ranged in length from 21 mm to 40 mm with a mean

length of 32 mm (N = 200). The *G. aculeatus* population had three age groups (0+, 1+, and 2+) indicating a life span of 2 years and some months. An age–length key for *G. aculeatus* is given in Table 1. Mean lengths of males and females of both species are given in Table 2. Females of the 1+ age group of *G. wheatlandi* were significantly larger than males of the same age group ($P < 0.001$). A similar situation was noted in *G. aculeatus* but only for the 2+ age group ($P < 0.001$).

TABLE 1. — Age-length key for *G. aculeatus*, Amory Cove, 1970–71.

Length (mm)	Age		
	0+	1+	2+
5–9	64		
10–14	116		
15–19	51		
20–24	4		
25–29		2	
30–34		1	
35–39			1
40–44			1
45–49			9
50–54			77
55–59			44
60–64			36
65–69			28
70–74			5
Total	235	3	201
Mean	11.9	28.7	57.1
S.D.	3.7396	2.8868	6.4311
S.E.	0.2439	1.6667	0.4536

Stomach Contents

Examination of stomach contents of both species showed that the predominant food items were small crustaceans and stickleback eggs. The crustacean component consisted mainly of gammarids and leptostracans with occasional isopods, ostracods and unidentified crustacean remains. Small polychaetes were found in 2% of stomachs of both species. Occasionally algal strands were present, possibly as an accidental inclusion with other items. Chironomids were a food item but occurred more frequently in *G. aculeatus* stomachs (20% of those examined) than in *G. wheatlandi* (8% of stomachs examined). Certain *G. aculeatus* specimens taken from tidal pools high on the shore were found to have been eating larvae and pupae of mosquitoes, and items such as Araneae and Collembola of terrestrial origin. There have been no detailed studies on food of these marine sticklebacks of eastern North America but general observations indicate that they feed on any available small organisms (Leim and Scott 1966).

TABLE 2. — Mean length of male and female *G. aculeatus* and *G. wheatlandi* in Amory Cove, 1970–71.

Age	Number of fish	Mean length	Range	Standard deviation	Standard error
G. aculeatus					
Males					
0+	18	15.6	13–21	1.8830	0.4438
1+	1	33.0	33	—	—
2+	109	54.0	42–67	4.8150	0.4612
Females					
0+	72	15.3	10–21	2.7011	0.3183
1+	2	28.5	28–29	—	—
2+	87	60.2	39–71	10.9298	1.1718
G. wheatlandi					
Males					
1+	88	29.9	21–35	4.0967	0.4367
Females					
1+	115	32.9	28–40	3.3191	0.3095

TABLE 3. — Egg numbers and egg diameters for *G. aculeatus* and *G. wheatlandi*, Amory Cove, 1971.

	Number of specimens	Mean length (mm)	Range	Mean	Standard deviation	Standard error
Number of eggs						
G. aculeatus	71	61	120–515	265	72.7897	8.6385
G. wheatlandi	53	33	75–168	126	24.9041	3.4208
Diameter of eggs						
G. aculeatus	29	60	1.01–1.60	1.25	0.1855	0.0344
G. wheatlandi	19	32	0.86–1.21	1.05	0.0996	0.0229

Reproduction

Data on egg numbers and egg diameters are given in Table 3. Linear regression of egg numbers on length for *G. aculeatus* gave the equation $y = 35.58 + 0.09\ x$ with confidence limits for x of 0.13 and 0.05 at the 5% level and a correlation coefficient of 0.70. For *G. wheatlandi* the linear equation was $y = 21.21 + 0.10\ x$ with confidence limits for x of 0.19 and 0.01 and a correlation coefficient of 0.66. Sex ratios of mature fish were 1.25 ♂ : 1 ♀ and 0.77 ♂ : 1 ♀ for *G. aculeatus* and *G. wheatlandi* respectively.

All adult *G. aculeatus* were caught during May, June, and July, 1971. Mature fish were 2+ years old and only three immature 1+ specimens were caught. These latter were probably strays and normally the 1+ age group remains in sub-littoral, coastal, or oceanic waters. Fry were first noted in shore pools on June 4, 1971 and it is probable that hatching begins in late May. About 1 month later (June 27) the majority of adult females had left the tidal pools high on the shore and were congregating in the center of Amory Cove, apparently on their way to the sea. Not all these females were spent and it was possible to catch gravid females 2 weeks later in certain tidal pools. The males remained in tidal pools protecting the young until late July when they also left. The young remained in the pools for some time and observations in 1970 indicated that they left only in the late fall, presumably to escape the ice cover of winter. No mass mortality after spawning was noted.

Breeding males had a red ventral surface and blue sides. The eye was tinged iridescent blue-green. Females did not show any obvious color change such as the brassy reflections on the sides observed by Leim and Scott (1966) and Berg (1949). However as the green filamentous algae increased in the pools the coloration of females took on a greenish tinge similar to the greenish-yellow of breeding *G. wheatlandi* males, and this phenomenon may explain some of the confusion between the species which was noted in the literature.

All specimens of *G. wheatlandi* caught in 1971 were adults approximately 1 year old. The males were all in breeding color, a lemon-yellow or greenish-yellow with distinct black markings and orange pelvic fins. Females did not acquire a breeding color. These observations agree with the descriptions in McInerney (1969) and Leim and Scott (1966).

Tidal Pool Conditions

The temperatures and salinities recorded during the study period are summarized in Table 4. The data for two pools which were never seen to be covered by the tide during the study period were grouped (A), as were the data for three pools which were covered occasionally (B). One pool (C) was seldom covered by the tide but may have been affected by seepage through the surrounding mud and sand.

The effect of rainfall on the salinity of the sea surface in Amory Cove was marked. This was an important consideration because surface water was the first to enter tidal pools and on many days the only water entering the pools.

TABLE 4. — Temperatures and salinities in tidal pools of Amory Cove, 1971.

Pool Group	Temperature °C		Salinity (grams NaCl/liter)	
	Mean	Range	Mean	Range
A	18	9.5–26.5	31.25	24.75–37.25
B	16	7.0–25.0	28.75	18.50–33.50
C	16	8.0–25.0	23.75	11.75–31.00
Sea (in Amory Cove)	11	3.5–17.0	25.50	10.50–32.25

A difference in salinity of 7.25 g NaCl/liter was noted between the sea surface, and a depth of about 0.5 m on June 8, 1971 after a heavy rainfall. Rainfall and subsequent surface runoff decreased salinity in the pools, e.g. B group average salinity decreased from 31 g NaCl/liter to 19.5 g NaCl/liter within 24 hours after approximately 0.03 inches of rain.

Insolation had the reverse effect of gradually increasing salinity by evaporation, e.g. after 0.02 inches of precipitation on 26 May 1971 the average salinity in Group B was 25.25 g NaCl/liter. Two days later after 28.7 hours of bright sunshine the salinity had risen to 27 g NaCl/liter.

The relative amounts of insolation and precipitation over short periods affected the salinity when there was no influx of seawater into the pools. Since neither condition obtained exclusively for long periods of time fluctuations in salinity were reduced.

Amory Cove, because of its shallow and sheltered nature, contained seawater which was often warmer than that of the Gulf of St. Lawrence. It was, however, always cooler than the water in the tidal pools on which it exerted a moderating influence.

The pools in Group A were invaded by sticklebacks probably in late April or early May. No tides were observed reaching these pools during the time of study. These pools had higher temperature and salinity means and ranges than those in the other groups because of their shallow and exposed nature. The small catchment area for rainwater around the pools limited the influence of precipitation on salinity.

Temperature conditions in pools of Groups B and C were very similar. Salinities were lower in the latter because of the large catchment area for precipitation. Pools of Group B received less runoff than did C but more than that received by Group A pools.

Predators

Only one species of predator on these sticklebacks was observed, a cottid, *Myoxocephalus scorpius* (L., 1758). Eleven individuals were caught and their stomach contents examined. Only one specimen, of 29.5 cm standard length, caught in Amory Cove contained sticklebacks. Four *G. aculeatus* were identified. A dead cottid, 22 cm standard length, found in a tidal pool of Group B contained 11 *G. aculeatus* adults. The pool temperature was 24°C and this was probably lethal to the cottid.

Phenotypic Variation

Meristic variation data for *G. aculeatus* of the 2+ age group and *G. wheatlandi* of the 1+ age group are summarized in Table 5. Four individuals of *G. aculeatus* had four dorsal spines (2% of those examined). All other specimens examined had three dorsal spines. All specimens of *G. wheatlandi* had three dorsal fin spines.

Paired and caudal fin ray counts of 50 specimens of each species gave the following results. Left pelvic counts were I,1 (one spine and one soft ray) in *G. aculeatus* and I,2 in *G. wheatlandi*. The left pectoral fin of *G. aculeatus* contained 10 rays in all but one individual. The major caudal fin ray count was 12 but one individual had only 11 rays. The left pectoral fin ray count for *G. wheatlandi* was also 10 and the major caudal fin ray count was 12 with one individual having 11 rays.

First dorsal spine length was expressed as a fraction of body depth below that spine for 0+ and 2+ age group individuals in the *G. aculeatus* population. There was no significant difference between these values for the two age groups ($P > 0.05$).

TABLE 5. — Meristic variation in *G. aculeatus* and *G. wheatlandi* of Amory Cove, 1971.

Lateral plates	5	6	7	8	9	10–	17–	28	29	30	31	32	33	34	35	N	$\bar{x}$	S.D.	S.E.
G. aculeatus							1	1	1	1	10	49	93	39	5	200	32.76	1.4912	0.1054
G. wheatlandi	10	43	72	61	13	3										202	7.16	1.0405	0.0732
Gill rakers	11	12	13	14	15	16	17	18	19	20	21	22	23						
G. aculeatus							2	23	55	58	47	14	1			200	19.86	1.1708	0.0828
G. wheatlandi	1		5	19	53	62	43	13	3	1						200	15.86	1.2932	0.0914
Vertebrae	27	28	29	30	31	32	33	34											
G. aculeatus					7	27		1								35	31.86	0.5500	0.0930
G. wheatlandi	3	27	12													42	28.21	0.5646	0.0871
Soft dorsal rays	5	6	7	8	9	10	11	12	13										
G. aculeatus						4	76	92	28							200	11.72	0.7240	0.0512
G. wheatlandi	1		5	30	103	56	7	1								203	9.14	0.8756	0.0615
Soft anal rays	5	6	7	8	9	10	11												
G. aculeatus				54	124	21	1									200	8.85	0.6106	0.0432
G. wheatlandi	3	38	110	50	2											203	7.05	0.7295	0.0512

Head length, body length, and caudal peduncle length were expressed in thousandths of standard length for both species of stickleback. There were no significant differences between the two species for head length and caudal peduncle length ($P > 0.05$) but body depth was greater in *G. wheatlandi* than in *G. aculeatus* ($P < 0.001$).

The development of spinules on the first and second dorsal spines and the ventral spines varied within each species but was more marked in specimens of *G. aculeatus* than in *G. wheatlandi*. The inner cusp on the ventral spine of *G. aculeatus* sometimes approached the degree of development said to be characteristic of *G. wheatlandi* but the latter usually bore a more distinct spinule at the base of the spine.

Discussion

Gasterosteus wheatlandi is at the northern limit of its range in this part of Québec (Van Vliet 1970; McAllister 1960). Power (1965) noted the presence of a population of this species in the Nabisipi River, 290 km to the east of Sept Iles in 1961 but not in 1962, which was a slightly cooler summer. May 1971 in the area of Sept Iles was slightly warmer than normal (+1.5°F) and it was about this time that *G. wheatlandi* arrived in tidal pools from the sea. Specimens of this species were particularly abundant in Amory Cove and only occasional individuals were found along the exposed coastline. *G. aculeatus* is well within its normal range in Québec waters (Leim and Scott 1966) but it too was also more abundant within the sheltered Cove. The shallow nature of Amory Cove was conducive to the maintenance of water temperatures warmer than those along the coast, e.g. July 2, 1971 at 12:00 pm the sea surface temperature in Amory Cove was 17°C while 1 km west on the exposed coastline, surface temperature was 10°C. The Cove was probably a preferred habitat for this reason.

No consensus of opinion has been reached on the age structure of *G. aculeatus* populations, and maximum age estimates range from just over 1 year up to 5 years of life (reviewed in Jones and Hynes 1950; Greenbank and Nelson 1959; Van Mullem and Van der Vlugt 1964. It seems probable that the life history of this species is governed by its environment although there may be genetic differences between iso-

lated populations (Greenbank and Nelson 1959). The age structure of Amory Cove *G. aculeatus* is similar to that of an Alaskan freshwater population examined by Greenbank and Nelson (1959).

Length–frequency studies were regarded by Jones and Hynes (1950) as being inapplicable to amphiboreal sticklebacks in England. A more severe climate and reduced growing season in Québec facilitate distinction of age groups in freshwater *G. aculeatus* by this method (Power 1965; confirmed by otolith studies (Coad (1972)). The absence of a large representative sample of marine 1+ age group *G. aculeatus* in Amory Cove precludes extension of this observation to marine populations.

McInerney (1969) maintained that *G. wheatlandi* lived for 1 year and some months, basing this assumption on the lack of size variation compared to other stickleback species and on aquarium observations of post-spawning individuals which survived only a few months. Otolith studies on the Amory Cove population confirmed this statement although mature fish varied in size from 21 mm to 40 mm standard length.

The adult female of both species was, on average, larger than the male. Bertin (1925), Leiner (1931), and Van Mullem and Van der Vlugt (1964) have also noted the larger size of adult female *G. aculeatus,* and that this distinction did not hold for younger fish. Perlmutter (1963) observed this sexual dimorphism in mature individuals of both species in the waters of Long Island, New York.

The spawning times for the *G. aculeatus* and *G. wheatlandi* populations in Amory Cove were similar to those recorded for other populations in eastern North America and elsewhere with similar temperature regimes (Leim and Scott 1966; McInerney 1969; Van Vliet 1970). Perlmutter (1963) studied populations of both species in Long Island Sound and suggested that *G. aculeatus* approaches the end of its spawning period at a time when *G. wheatlandi* is just beginning. *G. wheatlandi* of Amory Cove appeared to be spawning slightly later, on average, than *G. aculeatus,* but there was considerable overlap in this schedule. Reisman (1968) found Maine populations of the two species in different habitats during the spawning season but chance apparently governed the distribution of sticklebacks in tidal pools of Amory Cove. Despite similarities of habitat the two species exhibit well defined reproductive isolation (McInerney 1969).

The age of spawning of *G. wheatlandi* was 1 year. No record of survival and spawning at 2 years of age has been published. Reports of spawning age in *G. aculeatus* populations of Europe are varied (Bertin 1925; Wunder 1930; Craig-Bennett 1931; Jones and Hynes 1950). Greenbank and Nelson (1959), working in Alaska, found spawning to occur in 1-year-old lacustrine fish but in less than half the population. Whether these yearling spawners survived to breed a second time was not known. Power (1965) observed that sticklebacks from Lac Aigneau in Québec did not breed until the end of the second year of life as in the Amory Cove population. Narver (1969) observed maturation at a similar age in fish 50–65 mm long belonging to a lacustrine population in Alaska but not in marine sticklebacks which Narver considered to mature at 1 year. Variations in spawning age between populations seem to be common and may be a reflection of local conditions or local opinion.

Sampling bias makes sex ratios of mature sticklebacks uncertain. Males outnumbered females in *G. aculeatus* probably because of unwitting selection of brightly colored males over cryptic females in the tidal pools. Perlmutter (1963) found more females in his samples of marine *G. aculeatus* and this may be correlated with polygamy in this species. The *G. wheatlandi* male was not as brightly colored and the calculated sex ratio (0.77:1) may be more representative of the situation in nature. Polygamy may be important in this species, since females outnumber males, although neither our observations nor those of McInerney (1969) show this.

Egg diameters in *G. aculeatus* of Amory Cove (range 1.01–1.60 mm, mean 1.25 mm) were comparable to those of Newfoundland populations recorded by Van Vliet (1970) where the range was 0.5–2.0 mm. Bigelow and Schroeder

(1953) recorded Gulf of Maine populations with a mean egg diameter of 1.66 mm, and Bertin (1925) recorded European populations with a diameter range of 1.5–1.9 mm. These higher figures may be due to more favorable feeding conditions in milder climates. The egg diameters of the *G. wheatlandi* population (0.86–1.21 mm, mean 1.05) were comparable to the range 0.6–1.3 mm, reported by Van Vliet (1970) for Newfoundland populations, but lower than that cited by Scott and Crossman (1964), 1.2–1.5 mm, also for Newfoundland populations. Sampling time and variation in local conditions may be important factors in this diversity.

Egg numbers in *G. aculeatus* were higher than those for Gulf of Maine populations reported by Bigelow and Schroeder (1953), (120–515 in Amory Cove, 100–150 in Gulf of Maine) but similar numbers have been noted by Nikol'skii (1961) for Russian populations. Scott and Crossman (1964) reported a range in egg numbers for *G. wheatlandi* of 140–276 with a mean 186 in Newfoundland, which was higher than the Amory Cove sample, range 75–168, mean 126. Egg numbers are low in sticklebacks compared to those in other species of fish. A high degree of parental care of eggs and young ensures an adequate survival rate.

The temperature and salinity of tidal pools were affected by several environmental conditions. The elapsed time since the last tide to enter the pools varied with the height of the tide. When tides were low and did not enter the pools for several days the influence of surface freshwater runoff and insolation was greater than at times of high tides. High tides flooding the pools had a moderating influence on temperature. Salinity was usually decreased by tidal influx, particularly after a rainstorm had freshened sea surface waters.

The euryhalinity of *G. aculeatus* has been well documented (Nelson 1968; Baggerman 1957; Penczak 1959; Munzing 1963), and this species may be found ranging from freshwater to water almost three times as saline as seawater (Munzing 1963). It is also tolerant of salinity changes (Penczak 1959).

Gasterosteus aculeatus is able to withstand high temperatures of the order of 25°C and is also tolerant of temperature changes (Bertin 1925). The temperatures in the pools, therefore, were not excessively high and the mean temperatures were quite favorable.

Gasterosteus wheatlandi is also euryhaline but apparently prefers marine conditions (McAllister 1960; Van Vliet (1970). Its ability to withstand rapid salinity changes and high temperatures has not been examined in the laboratory. No mass mortality was observed in tidal pools during the course of this study and this species survived temperatures up to 25°C.

The tidal pools provided an environment for stickleback reproduction which was more stable with respect to salinity than the surface of Amory Cove (Table 6). Sub-littoral waters were probably much more stable in both salinity and temperature. However the higher temperatures in the tidal pools facilitated egg development. Wheeler (1969) states that hatching occurs in 8 days for *G. aculeatus* when the temperature is 17–18°C. McPhail and Lindsey (1970) quote similar figures. It seems therefore, that the tidal pools offer a favorable temperature regime coupled with a salinity range which is not as variable as that in the Cove. A measure of protection against such predators as the cottid *Myoxocephalus scorpius* (L., 1758) was afforded by the isolation of the pools and their high temperatures.

The range of variation of meristic characters in *G. aculeatus* was similar to that observed in other marine trachurus populations of eastern North America (Bigelow and Schroeder 1953; Perlmutter 1963; Leim and Scott 1966; Van Vliet 1970; Thomson *et al.* 1971). With regard to lateral plates, the majority of *G. aculeatus* conformed to the trachurus type with continuous plates along the flanks and a pronounced caudal keel. Occasional specimens had some posterior plates missing or reduced. Only one individual had a definite posterior gap in the plates and a distinct, lower plate count of 17. Such a semiarmatus type may have been a stray from nearby rivers.

Detailed analyses of meristic variation between *G. wheatlandi* populations have not been

performed. Some ranges and means for meristic characters are given by Bigelow and Schroeder (1953), Perlmutter (1963), Scott and Crossman (1964), and Van Vliet (1970), and are similar to the values obtained for the Amory Cove population. Plate count for the Long Island Sound populations of Perlmutter (1963) were exceptional however. The count was high and plates extended to the caudal region in most specimens. Assuming the identification of *G. wheatlandi* was not confused with *G. aculeatus,* this population must be regarded as unusual. Perlmutter (1963) also found a significant difference between male and female plate number in *G. wheatlandi.* Males had fewer plates than did females. A similar situation was obtained for the Amory Cove population with mean male plate number (6.53) being significantly less than mean female plate number (7.59) ($P < 0.05$).

It was noted in Coad (1972) that first dorsal spine length in relation to body depth of *G. aculeatus* may be greater in 0+ age group fish as compared to older fish. This phenomenon seems to be limited to freshwater populations of this species where predators are more numerous than in tidal pools. Hagen and Gilbertson (1972) have shown that the length of dorsal and pelvic spines is significantly greater where predators are more common. Proportionally longer spines increase the size of small fish and reduce the number of effective predators.

Development of lateral plates may be related to predators. Marine populations of *G. aculeatus* are almost invariably heavily plated (the "trachurus" form) and this may increase survival by reducing flesh lacerations. Freshwater populations with fewer plates may be a consequence of heavier demands on the energy resources of the fish in a less rich environment than the sea. Marine populations also have the advantages of the greater bouyancy of their medium and higher carbonate concentrations and so can afford heavy plates for protection.

Hubbs (1929) and McAllister (1960) noted that the following characters may be used to distinguish *G. wheatlandi* from marine *G. aculeatus:* prominent basal cusps on each side of the pelvic spine; two soft rays in the pelvic fin; lower numbers of gill rakers, dorsal and anal soft rays; only anterior plates usually; no caudal keel; different breeding colors; a deeper body and a shorter caudal peduncle. In the Amory Cove populations however the caudal peduncle length was not significantly shorter. Head length in *G. wheatlandi* as cited by Leim and Scott (1966) was shorter than that recorded for Connecticut *G. aculeatus* by Thomson *et al.* (1971), but this character difference has not been recorded elsewhere and did not occur in the Amory Cove populations. Nelson (1971) noted that in *G. aculeatus* the posttemporal and supracleithrum are present, while in *G. wheatlandi* they are absent. *G. wheatlandi* had fewer vertebrae than *G. aculeatus* in Amory Cove, an additional distinctive character which may be added to the above list.

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Literature Cited

Baggerman, B. 1957. An experimental study on the timing of breeding and migration in the three-spined stickleback (*Gasterosteus aculeatus* L.). Archives Néerlandaises de Zoologie 12: 105–318.

Berg, L. S. 1949. Freshwater fishes of the U.S.S.R. and adjacent countries. 4th edition. Translated from Russian, Israel Program for Scientific Translations, Jerusalem, 1964. 3 volumes.

Bertin, L. 1925. Recherches bionomiques biométriques et systématiques sur les épinoches (Gastérostéidés). Annales de l'Institut Océanographique, Monaco, 2: 1–204.

Bigelow, H. B. and **W. C. Schroeder.** 1953. Fishes of the Gulf of Maine. Fishery Bulletin, Fish and Wildlife Service, United States Department of the Interior 74: 1–577.

Coad, B. W. 1972. On the ecology and meristic variation of the Gasterosteidae of the Matamek River System, Quebec. M.Sc. Thesis, University of Waterloo, Waterloo, Ontario.

Craig-Bennett, M. A. 1931. The reproductive cycle of the threespined stickleback, *Gasterosteus aculeatus,* Linn. Philosophical Transactions of the Royal Society. Series B. London 219: 197–279.

Greenbank, J. and **P. R. Nelson.** 1959. Life history of the three-spine stickleback *Gasteresteus aculeatus* Linnaeus in Karluk Lake and Bare Lake, Kodiak Island, Alaska. Fishery Bulletin, Fish and Wildlife Service, United States Department of the Interior 59: 537–559.

Hagen, D. W. 1967. Isolating mechanisms in threespine sticklebacks (*Gasterosteus*). Journal of the Fisheries Research Board of Canada 24: 1637–1692.

Hagen, D. W. and **L. G. Gilbertson.** 1972. Geographic variation and environmental selection in *Gasterosteus aculeatus* L. in the Pacific Northwest, America. Evolution 26: 32–51.

Heuts, M. J. 1947. The phenotypical variability of *Gasterosteus aculeatus* (L). populations in Belgium. Its bearing on the general geographical variability of the species. Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen Letteren et Schone Kunston van Belgie Klasse der Wetenschappen 9: 1–63.

Hubbs, C. L. 1929. The Atlantic American species of the fish genus *Gasterosteus.* Occasional Papers of the Museum of Zoology, University of Michigan 200: 1–9.

Hubbs, C. L. and **K. F. Lagler.** 1958. Fishes of the Great Lakes region. University of Michigan Press, Ann Arbor, Michigan. 213 pp.

Jones, J. W. and **H. B. N. Hynes.** 1950. The age and growth of *Gasterosteus aculeatus, Pygosteus pungitius* and *Spinachia vulgaris,* as shown by their otoliths. Journal of Animal Ecology 19: 59–73.

Leim, A. H. and **W. B. Scott.** 1966. Fishes of the Atlantic Coast of Canada. Bulletin No. 155, Fisheries Research Board of Canada, Ottawa. 485 pp.

Leiner, M. 1931. Ökologisches von *Gasterosteus aculeatus* L. Zoologischer Anzeiger 93: 317–333.

McAllister, D. E. 1960. The twospine stickleback *Gasterosteus wheatlandi* new to the Canadian freshwater fish fauna. Canadian Field-Naturalist 74: 177–178.

McInerney, J. E. 1969. Reproductive behaviour of the black-spotted stickleback, *Gasterosteus wheatlandi.* Journal of the Fisheries Research Board of Canada 26: 2061–2075.

McPhail, J. D. and **C. C. Lindsey.** 1970. Freshwater fishes of Northwestern Canada and Alaska. Bulletin No. 173, Fisheries Research Board of Canada, Ottawa. 381 pp.

Munzing, J. 1959. Biologie, Variabilität und Genetik von *Gasterosteus aculeatus* L. (Pisces). Untersuchungen in Elbegebeit. Internationale Revue der Gesamten Hydrobiologie und Hydrographie 44: 317–382.

Munzing, J. 1963. The evolution of variation and distributional patterns in European populations of the threespined stickleback *Gasterosteus aculeatus.* Evolution 17: 320–332.

Narver, D. W. 1969. Phenotypic variation in threespine sticklebacks (*Gasterosteus aculeatus*) of the Chignik River System, Alaska. Journal of the Fisheries Research Board of Canada 26: 405–412.

Nelson, J. S. 1968. Salinity tolerance of brook sticklebacks, *Culaea inconstans,* freshwater ninespine sticklebacks, *Pungitius pungitius,* and freshwater fourspine sticklebacks, *Apeltes quadracus.* Canadian Journal of Zoology 46: 663–667.

Nelson, J. S. 1971. Comparison of the pectoral and pelvic skeletons and of some other bones and their phylogenetic implications in the Aulorhynchidae and Gasterosteidae (Pisces). Journal of the Fisheries Research Board of Canada 28: 427–442.

Nikol'skii, G. V. 1961. Special ichthyology. Translated from the Russian, Israel Program for Scientific Translations, 1961. 528 pp.

Nikolsky, G. V. 1963. The ecology of fishes. Academic Press, New York and London. 352 pp.

Penczak, T. 1959. Odpornosc ciernika, *Gasterosteus aculeatus* L., na zmiany cisnienia osmotycznego i dzia l'anie roznyck soli. Przeglad Zoologiczny 3: 100–105.

Penczak, T. 1965. Morphological variation of the stickleback (*Gasterosteus aculeatus* L.) in Poland. Zoologica Poloniae 15: 3–49.

Penczak, T. 1966. Comments on the taxonomy of the three-spined stickleback, *Gasterosteus aculeatus* Linnaeus. Ohio Journal of Science 66: 81–87.

Perlmutter, A. 1963. Observations on fishes of the genus *Gasterosteus* in the waters of Long Island, New York. Copeia 1963: 168–173.

Power, G. 1965. Notes on the cold-blooded vertebrates of the Nabisipi River region, County Duplessis, Quebec. Canadian Field-Naturalist 79: 49–64.

Reisman, H. M. 1968. Reproductive isolating mechanisms of the blackspotted stickleback, *Gasterosteus wheatlandi.* Journal of the Fisheries Research Board of Canada 25: 2703–2706.

Scott, W. B. and **E. J. Crossman.** 1964. Fishes occurring in the fresh waters of Insular Newfoundland. Department of Fisheries of Canada, Ottawa. 241 pp.

Thomson, K. S., W. H. Weed, and **A. G. Taruski.** 1971. Saltwater fishes of Connecticut. Bulletin 105, State Geological and Natural History Survey of Connecticut.

Van Mullem, P. J. and **J. C. Van der Vlugt.** 1964. On the age, growth and migration of the anadromous stickleback, *Gasterosteus aculeatus* L., investigated in mixed populations. Archives Néerlandaises de Zoologie 16: 111–139.

Van Vliet, W. H. 1970. Shore and freshwater fish collections from Newfoundland. Publications in Zoology, No. 3, National Museum of Natural Sciences, Ottawa.

Wheeler, A. 1969. The fishes of the British Isles and North-West Europe. MacMillan, London. 613 pp.

Wunder, W. 1930. Experimentelle Untersuchungen am driestachligen Stichling (*Gasterosteus aculeatus* L.) während der Laichzeit (Kämpfe, Nestbau, Laichen, Brutpflege). Zeitschrift fur Morphologie und Ökologie der Tiere 16: 453–498.

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Behavioral Interactions between Two Species of Red-backed Vole (*Clethrionomys*) in Captivity

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Murie, J. O. and D. Dickinson. 1973. Behavioral interactions between two species of red-backed vole (Clethrionomys) in captivity. Canadian Field-Naturalist 87: 123-129.

Abstract. The nature of interactions between captive *Clethrionomys rutilus* and *C. gapperi* were analyzed in two situations: groups of four individuals of each species in a 122 × 244 cm enclosure ($n = 2$), and pairs of one individual of each species in a circular arena 75 cm in diameter ($n = 40$). The objective was to determine whether consistent behavioral interactions occur that could be involved in maintaining spatial separation of these species in areas of potential sympatry. In the enclosure *C. rutilus* males were dominant over *C. gapperi*. In encounters between two individuals, *C. gapperi* showed strong avoidance reactions and *C. rutilus* tended to be indifferent toward *C. gapperi*. These results indicate that *C. gapperi* could be deterred from settling in areas occupied by *C. rutilus*. In both experimental situations, *C. gapperi* were more active than *C. rutilus*, and this difference could partially compensate for the apparent subordinance of *C. gapperi*. However, lower activity by *C. rutilus* may be an adaptation for reducing energy expenditure and could result in an increasing competitive advantage over *C. gapperi* along a latitudinal gradient northward.

Introduction

Two species of red-backed vole, *Clethrionomys rutilus* and *C. gapperi*, are widespread in North America. *Clethrionomys rutilus* occurs in Alaska, Yukon Territory, and the Northwest Territories; *C. gapperi* exists in more southerly areas across Canada and the United States (Hall and Kelson 1959). Macpherson (1965) hypothesized that these two species existed in different refugia (Beringia and south of the ice sheets, respectively) during Pleistocene glaciation, and since then populations of both species have expanded to meet, or nearly meet, in several areas. However, their ranges are not known to overlap. Near Great Slave Lake in the Northwest Territories, the ranges of these two voles meet at the Kakisa River, but during about 10 years of trapping, only a few individuals have been captured on the "wrong" side of the river (Fuller 1969).

The Kakisa River is not likely to act as a barrier to dispersal over a period of years, especially considering that it is frozen through much of the winter. Furthermore, Dyke (1971) found that both species had similar food and cover requirements and occupied similar habitats in this region. Therefore it seems that other factors must act to maintain spatial separation of these two species of *Clethrionomys*. This report is a preliminary investigation of behavioral interactions that could be involved in maintaining separation in areas of potential sympatry.

Fuller (1969) suggested that *C. rutilus* may have a greater ability to tolerate cold temperature in winter than does *C. gapperi*. Sealander (1966), on the basis of his work on blood physiology of *C. rutilus*, supports this idea and suggests that northern species of voles have achieved more effective insulation than their congeners at lower latitudes. Our a *priori* hypothesis was that (1) *C. gapperi* are not as well adapted as *C. rutilus* to survive winter conditions, and therefore would not be able to establish themselves north of their present range, in areas occupied by *C. rutilus*, and (2) *C. gapperi* exhibit behavioral dominance over *C. rutilus*, and this prevents the latter species from extending southward into areas occupied by *C. gapperi*. This study concerns only the second part of this hypothesis.

Methods

Two methods were used to assess behavioral relationships between these species.

Groups of voles were observed in a 122 × 244 cm wooden enclosure, 122 cm high, with a partition dividing it into two 122 × 122 cm

compartments. A food dish and water dispenser were present in each compartment. The bottom was covered with 4–8 cm of commercial peat moss. Each compartment held three wooden nestboxes (20 × 20 × 8 cm) containing terylene nest material. The enclosure was kept in a basement at 20 ± 5°C with a 10L/14D photoperiod. During the light cycle (0900–1900), two 100-watt incandescent bulbs were operating. The enclosure was constantly illuminated by two fluorescent red lights.

Observations were made on two sets of individuals. For each set, two male and two female *C. rutilus* were established in one compartment, and two male and two female *C. gapperi* were placed in the other. Weights of individuals of the two species were matched as closely as possible but most *C. gapperi* were slightly heavier than *C. rutilus*. After 25 days (Set I) and 8 days (Set II) of observation, two doors in the partition were opened and observations were continued for 14 and 17 days, respectively. Voles were individually marked by hair-clipping. Notes were made on general activity and all interactions both before and after partition doors were opened.

Interactions between individuals were classified as agonistic if a vole assumed a defensive posture or attacked when approached by another vole. If an individual retreated from an approaching vole, the interaction was classed as avoidance. All other interactions were considered amicable. Only encounters in which a decision on which individual was dominant could be made were used in assessing social rank, either within or between species.

Observation periods were of 10 to 15 min duration, once or twice a day, usually near the beginning and end of the dark cycle. For Set I, observation times were 372 min for *C. gapperi* and 358 min for *C. rutilus* before the partition doors were opened, and 261 min after the doors were opened. Observation times for Set II were 50 min for *C. gapperi* and 62 min for *C. rutilus* while separated, and 179 min for each after the partition doors were opened. Set I extended from February 28 to April 8, 1969; Set II from April 24 to May 19, 1969.

A series of tests between pairs of voles was conducted in a circular arena, 75 cm in diameter and 40 cm high. The floor was wood coated with fiberglass and the walls were thin plexiglass. A removable partition divided the arena in half. Wood shavings covering the floor were changed after every four or five tests. Tests were conducted between 1130 and 1600 hours during the light period of an 8L/16D photoperiod. At each test, one vole was placed on each side of the partition. After a settling-down period of 2 to 5 min, the partition was removed and subsequent activity and interactions were recorded for 15 min. If severe fighting occurred, the test was shortened to avoid serious injuries.

Approaches toward one vole by another were classified as (*a*) amicable — approach with a "casual" exploratory manner, without postures described by Johst (1967) as associated with aggression, (*b*) aggressive — approach characterized by dominant postures (Johst 1967), and (*c*) ambivalent — hesitant initial approach followed by retreat of approacher. The first two types are interpreted as indicating self-assurance and dominance, the last as indicating a tendency toward subordinance or avoidance. Responses to approaches were classified as (*a*) retreat — moving away, either rapidly or slowly, without contact with the approacher, (*b*) defense — showing defensive threat postures and vocalizations, and (*c*) indifference — turning or extending head toward approacher but otherwise showing no overt reaction. Retreat is considered avoidance; defense and indifference are interpreted as usually indicating self-assurance and dominance.

Nineteen *C. rutilus,* 8 males and 11 females, and 20 *C. gapperi,* 11 males and 9 females, were used in 10 series of 10 tests each; conspecifics of the same sex (for both males and females) and conspecifics of opposite sex for each species; interspecific males; interspecific females; *C. rutilus* male and *C. gapperi* female; and *C. rutilus* female and *C. gapperi* male. All intraspecific tests were run before interspecific tests. Within each series, the number of tests for each individual was balanced; in five of the

tests pairs with similar weights were selected, in the other five tests individuals were chosen randomly. Average weights of *C. gapperi* were greater than those of *C. rutilus*.

C. gapperi were captured in Longworth traps between mile 70 and mile 90 along the Mackenzie Highway south of Great Slave Lake, N.W.T. *C. rutilus* were captured in the vicinity of Fort Providence, N.W.T. (see Fuller (1969) for map and description of the area). Voles for enclosure studies were captured in August 1968 and kept in shoebox cages (28 × 18 × 13 cm) in conspecific groups of two or three until they were used. Voles for pair tests were captured in August 1971 and maintained individually in shoebox cages until they were used about 4 months later. All voles received laboratory rat chow and water *ad libitum*.

The densities of the populations from which these voles came in 1971 were about the same, but in 1968 population density of *C. gapperi* was very low, about one quarter the level in 1971 (Fuller, personal communication). *C. rutilus* captured in 1968 were from a locally dense population, probably as high or higher than populations were in 1971, but we have no comparable index of density for this population.

Results

Groups

General level of activity of the voles is expressed in terms of the percentage of observation time that each was active outside the nestboxes (Figure 1). In both pens, activity of *C. gapperi* was significantly higher than activity of *C. rutilus* (for males alone, $P = 0.03$; for females alone, $P = 0.014$; for males and females combined, $P = 0.001$ (Mann-Whitney U tests described by Siegel, 1956)). In neither species were there significant differences in activity level between males and females but male *C. rutilus* and female *C. gapperi* were more active in Set II than in Set I, perhaps owing to the approach or onset of the breeding season, although no increase in reproductive behavior was noted. For each species, activity during the first portion of observations, when voles were in conspecific groups, was compared to later activity levels, when voles had access to both compartments. Although a few individuals of each species showed marked changes in activity (Figure 1), no consistent trend was evident for either species (*C. gapperi*, $P \leqslant 0.32$; *C. rutilus*, $P \leqslant 0.22$ (Wilcoxon signed-rank test described by Siegel, 1956)). Therefore there is no evidence that individuals of either species were avoiding the other species by spending more time in nestboxes.

Intraspecific interactions for the entire observation period, both before and after partition doors were opened, are combined in Table 1. In Set I the numbers of each kind of intraspecific interaction for *C. gapperi*, before and after partition doors were opened, were not significantly different. However, in Set II more amicable and fewer avoidance and agonistic interactions between *C. gapperi* occurred before the partition doors were opened than after ($\chi^2 = 9.95$, 2 df, $P < 0.01$). All interactions noted between *C. rutilus* occurred after partition doors were opened, except for one intensive fight between *C. rutilus* males in Set II.

A greater number of interactions occurred between *C. gapperi* than between *C. rutilus*. This difference appears to be a function, at least in part, of differences in activity. On several occasions squeaks and scuffling were heard in nestboxes occupied by *C. rutilus*, so some agonism was expressed while voles were not visible to me. Nearly all *C. rutilus* interactions observed were agonistic interactions between males whereas *C. gapperi* exhibited many amicable encounters as well as numerous agonistic interactions, the latter mainly between males (Table 1).

The nature of intraspecific dominance relationships was difficult to determine for *C. rutilus* because of their low activity and infrequent interactions. In Set I, no indication of social rank among *C. rutilus* was observed, and in Set II only the definite dominance of one male over the other male was apparent. Among *C. gapperi* in Set I, one male was dominant over the other male and one female, the other male was dominant over both females, and the dominance relationship between females was not apparent.

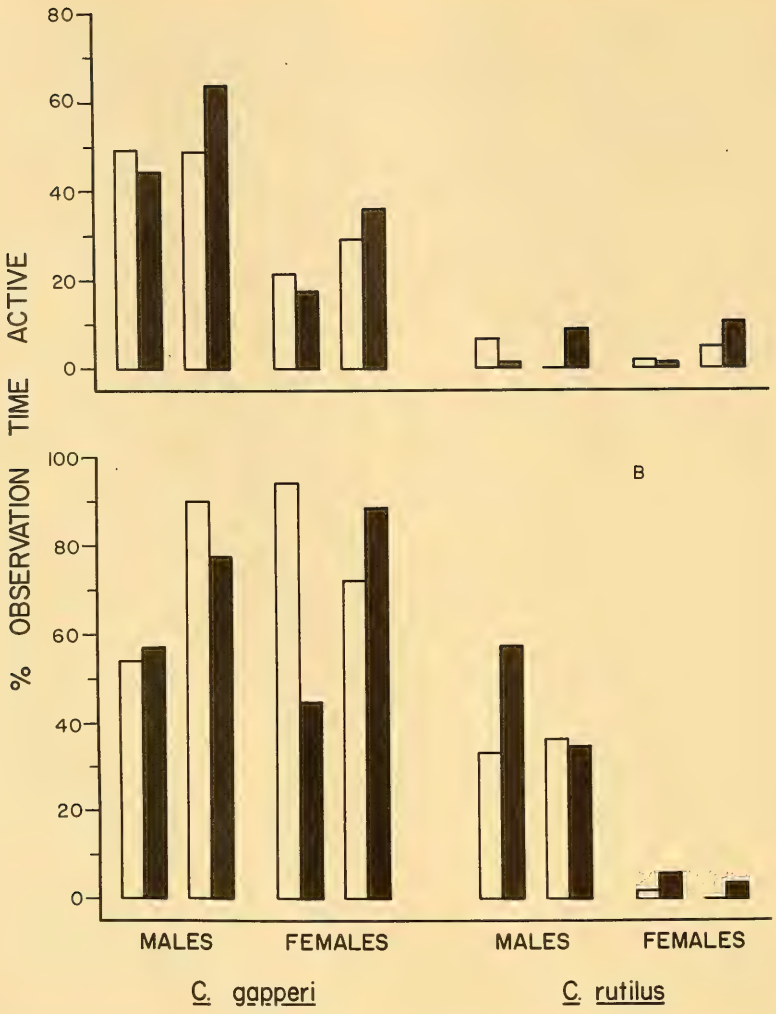

FIGURE 1. Activity of *Clethrionomys gapperi* and *C. rutilus* for two sets of voles (Set I, A; Set II, B), expressed as percentage of observation time that each individual was active outside the nestboxes. Open bars represent activity when species were separated by a partition; closed bars represent activity when doors in partition were open. (See text for total observation times for each set.) Each pair of bars represents an individual vole.

In Set II the only clear-cut dominance observed among *C. gapperi* was between males.

All interspecific interactions in Set I involved only one male *C. rutilus*. Most interactions were agonistic (Table 1) and the male *C. rutilus* was dominant over all four *C. gapperi*. In all 13 agonistic encounters, the male *C. rutilus* was the aggressor and chased *C. gapperi* individuals; the three instances of avoidance were *C. gapperi's* avoiding the male *C. rutilus*.

In Set II both *C. rutilus* males interacted with *C. gapperi*. The dominant male *C. rutilus* exhibited clear-cut dominance over all four *C. gapperi* (in a total of 30 agonistic interactions and nine occurrences of avoidance by *C. gapperi*). The other male *C. rutilus* was dominant over both male and one female *C. gapperi* (based on 10 agonistic and three avoidance interactions).

Of the 68 interspecific encounters in which

TABLE 1. — Summary of intraspecific and interspecific interactions in *Clethrionomys gapperi* and *C. rutilus* in two sets of voles observed. Intraspecific interactions are combined totals for both before and after partition doors were opened (see text for details).

	Set I			Set II		
	Amicable	Avoidance	Agonistic	Amicable	Avoidance	Agonistic
C. gapperi						
♂–♂	15	13	50	1	2	19
♀–♀	1	0	0	12	0	7
♂–♀	22	5	20	29	3	13
Totals	38	18	70	42	5	39
C. rutilus						
♂–♂	0	0	1	1	0	12
♀–♀	1	0	0	0	0	0
♂–♀	0	0	0	0	0	1
Totals	1	0	1	1	0	13
C. gapperi–rutilus						
♂–♂	1	1	10	0	7	24
♀–♀	1	0	0	0	0	0
♀–♂	1	2	3	16	6	16
♂–♀	0	0	0	0	0	0
Totals	3	3	13	16	13	40

dominance by one of the two individuals could be ascribed, *C. rutilus* were dominant in 65 cases, *C. gapperi* in only three.

Pairs

Approaches and responses in intra- and interspecific tests for each species are summarized in Table 2 with the results of appropriate Chi-square analyses.

In intraspecific tests, *C. rutilus* showed more amicable and fewer ambivalent approaches, and fewer retreats and more defense than did *C. gapperi*. A similar pattern emerged in interspecific tests; more amicable and fewer ambivalent approaches and fewer retreats and more indifferent responses by *C. rutilus* than by *C. gapperi*. These differences indicate that avoidance is a prominent feature of *C. gapperi* social interactions, whereas *C. rutilus* is more contactually oriented (also indicated by a higher frequency of huddling than shown by *C. gapperi*), and perhaps relies more on close-range threat than on initial avoidance to maintain spatial separation.

In interspecific tests, *C. gapperi* continued to show strong avoidance reactions and *C. rutilus* tended to approach amicably and to remain indifferent to ambivalent approaches by *C. gapperi*. Differences in behavior of *C. rutilus* in inter- versus intra-specific tests (Table 2) consist of fewer ambivalent approaches to *C. gapperi*, less frequent retreat and more indifference directed toward *C. gapperi* than when with conspecifics. On the other hand, *C. gapperi* show more ambivalent and fewer amicable approaches toward *C. rutilus* than toward conspecifics. Both species show less defense in interspecific tests than with conspecifics, but for *C. rutilus* this is probably owing to lack of other than ambivalent approaches by *C. gapperi*, while for *C. gapperi* this decrease in defense more likely reflects subordinance to *C. rutilus*.

In general, analysis of approaches and responses suggests that *C. rutilus* was less affected by interspecific interactions than *C. gapperi*, and *C. gapperi* avoided direct confrontation with *C. rutilus*. These results indicate that in terms of use of space, *C. rutilus* tend to dominate *C. gapperi*.

Within each of the categories summarized in Table 2, different combinations of sex have similar distributions of kinds of approaches

TABLE 2. — Summary of types of responses and approaches by *Clethrionomys rutilus* and *C. gapperi* in intra- and inter-specific pair tests of 15 min each (based on 30 intraspecific tests for each species and 40 interspecific tests). Results of Chi-square analyses for appropriate comparisons shown at bottom.

	Intraspecific tests (n = 30)		Interspecific tests (n = 40)	
	C. rutilus	*C. gapperi*	*C. rutilus*	*C. gapperi*
Type of approach				
Amicable	75	81	97	13
Aggressive	2	11	6	2
Ambivalent	41	126	28	11
Totals	118	218	131	128
Type of response				
Retreat	55	179	33	114
Defense	49	23	7	3
Indifference	14	16	88	14
Totals	118	218	128	131

Comparison	Chi-square	
	Approaches	Responses
C. rutilus, intra- vs inter-specific	6.6*	89.8**
C. gapperi, intra- vs inter-specific	35.1**	8.9*
Interspecific, *C. rutilus* vs *C. gapperi*	117.3**	99.7**
Intraspecific, *C. rutilus* vs *C. gapperi*	21.9**	49.9**

*$P < 0.05$. Critical $\chi^2_{2df,\ P < .05} = 5.99$.
**$P < 0.001$. Critical $\chi^2_{2df,\ P < .001} = 13.82$.

and responses (Chi-square tests were not used because of the large number of expected values less than 5 when data were partitioned by sex). The only striking difference was within *C. rutilus* intraspecific tests; nearly all approaches by females toward males were ambivalent, while a majority of aproaches by females to females and males to either sex were amicable. Also female *C. rutilus* showed more defensive responses toward conspecific males than toward other voles. Fights occurred only three times; in one test between male *C. rutilus,* and in two tests one male *C. gapperi* fought and was dominant over one male and one female *C. rutilus.*

C. gapperi were more active than *C. rutilus,* both in terms of number of approaches in intraspecific tests and time spent exploring a half of the arena during the settling-down period before each test.

Discussion

The results of the study of groups suggest that male *C. rutilus* are behaviorally dominant over *C. gapperi,* and presumably this relationship and the strong avoidance shown by *C. gapperi* in pair tests, could deter settling by *C. gapperi* in areas occupied by *C. rutilus.* But because *C. gapperi* are more active than *C. rutilus,* as shown in this study and elsewhere (Friesen 1972), this behavioral dominance may not be simply equated with ecological dominance. Greater activity by *C. gapperi* could counteract their seeming subordinance and perhaps give them a competitive advantage over *C. rutilus* in areas of sympatry.

The difference in activity between these two species may also have energetic implications that relate to their distribution. Low activity levels by *C. rutilus* could be an adaptation for reducing energy expenditure during seasons of critically low ambient temperature. Higher activity of *C. gapperi* and associated higher energy demands could place them at an increasing competitive disadvantage to *C. rutilus* along a latitudinal gradient northward.

Another cautionary note concerns the year-to-year stability of behavioral relationships. Krebs (1970) documented changes in relative aggressiveness of *Microtus* with changes in population density. We did not find major differences in behavior of *C. gapperi* from populations of different densities, but since voles were not tested in the same kind of situation, we cannot make a quantitative comparison. Therefore the dominance relationships in these species of *Clethrionomys* should be re-assessed periodically over several years and at different seasons of the year before drawing concrete conclusions.

Our original hypothesis that *C. gapperi* is behaviorally dominant over *C. rutilus* is not supported by these results, but dominance of *C. rutilus* males over *C. gapperi* and the difference between the species in activity levels are factors that may influence the maintenance of spatial separation of these two species.

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Literature Cited

Dyke, G. R. 1971. Food and cover of fluctuating populations of northern cricetids. Ph.D. thesis, University of Alberta, Edmonton, Alberta. 245 pp.

Friesen, J. 1972. Spatial and temporal utilization of semi-natural enclosures by *Clethrionomys gapperi, Clethrionomys rutilus, Peromyscus maniculatus*. M.Sc. thesis, University of Alberta, Edmonton, Alberta. 91 pp.

Fuller, W. A. 1969. Changes in numbers of three species of small rodent near Great Slave Lake, N.W.T., Canada, 1964–1967, and their significance for general population theory. Annales Zoologici Fennici 6: 113–144.

Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America. The Ronald Press Company, New York. 1083 pp.

Johst, V. 1967. Vergleichende Untersuchung des agonistischen Verbalten einiger Arten von *Clethrionomys*. Zeitschrift für Tierpsychologie 24: 213–224.

Krebs, C. J. 1970. *Microtus* population biology: Behavioral changes associated with the population cycle in *M. ochrogaster* and *M. pennsylvanicus*. Ecology 51: 34–52.

Macpherson, A. H. 1965. The origin of diversity in mammals of the Canadian Arctic tundra. Systematic Zoology 14: 153–173.

Sealander, J. A. 1966. Seasonal variations in hemoglobin and hematocrit values in the northern red-backed mouse, *Clethrionomys rutilus dawsoni* (Merriam), in interior Alaska. Canadian Journal of Zoology 44: 213–224.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company, Inc., New York. 312 pp.

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Distribution of the Dusky Salamander *Desmognathus fuscus fuscus* (Caudata: Plethodontidae) in Quebec, with Special Reference to a Population from St. Hilaire

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Pendlebury, G. B. 1973. Distribution of the Dusky Salamander *Desmognathus fuscus fuscus* (Caudata: Plethodontidae) in Quebec, with Special Reference to a Population From St. Hilaire. Canadian Field-Naturalist 87: 131–136.

Abstract. The Dusky Salamander *Desmognathus fuscus fuscus* is a wide-ranging species that reaches the northern limit of its range in southern Quebec. This salamander's known occurrences in the Appalachian Region of Quebec and the Monteregian Hills are briefly discussed. Special consideration is given to a population of *D. f. fuscus* that inhabits a spring-fed pond on the St. Lawrence Lowlands, 1.1 km west of St. Hilaire Mountain.

The widely distributed and highly variable plethodontid salamander *Desmognathus fuscus fuscus* reaches the northern limit of its range in southern Quebec. The species occurs commonly in the Appalachian Mountain System in southeastern Quebec, but there are few reports of occurrences outside this area. In this paper, earlier records of *D. f. fuscus* in Quebec are evaluated, the known distribution in the province is summarized, new occurrences are reported, and a disjunct population from St. Hilaire is discussed in some detail.

The occurrences plotted in Figure 1 are based on (*1*) museum specimens, (*2*) collections made by the writer, and (*3*) collections made by others and reported to the writer.

Distribution within the Appalachian Region

Dispersion of *D. f. fuscus* has been along the northeast-trending Appalachian Mountain System that extends from the state of Georgia to Newfoundland. Conant (1958) mapped the range of this salamander in Quebec as being completely within the Appalachian Region. Bleakney (1958) showed that the species has a greater range and indicated a record near the St. Lawrence River east of Quebec City as the northernmost occurrence in this region. The locality is not given but F. R. Cook (personal communication, 8 June 1972) informed me this locality is based on NMNS (Herpetology Unit, National Museum of Natural Sciences) 3124, three specimens collected at Lac Trois-Saumons, L'Islet County on 25 June 1954 by R. Dumais. Although 225 km separate this occurrence from the continuous range of *D. f. fuscus,* it is worthy of note that this disjunct population exists within the Appalachian Region. The known range was subsequently extended 66 km to the northeast when Denman (1963) reported a specimen that has been in the Redpath Museum, McGill University for almost a century. Most of the records from Quebec cited by Logier and Toner (1961) are based on Bleakney's (1958) work, and all are restricted to the Eastern Townships area of Quebec's Appalachian Mountain System.

As can be seen from Figure 1, most of the Quebec occurrences are from hilly or low mountainous areas in the Appalachian Region. The southern portion of this region in Quebec is approximately 130 km wide and consists of the Stoke, Sutton and Lake Mégantic Ranges. North of the Chaudière River, a single range 48 to 81 km wide is present (Dresser and Denis 1944).

The majority of records from the Stoke and Sutton Ranges are from elevations between 150

and 300 m. However, a few specimens have been collected from above 450 m near Foster Mountain. Dusky Salamanders are known from only one location on the western edge of the Lake Mégantic Range (W. F. Weller, in preparation. Additional records of stream and spring salamanders from Quebec, Vermont and Maine).

The streams which support populations of *D. f. fuscus* in these areas are cool and fast-moving by virtue of their source areas and the topography. Drainage is generally to the northwest, as this area is within the watershed of the St. Lawrence River.

Distribution outside the Appalachian Region

As previously mentioned, there are few known occurrences of *D. f. fuscus* in Quebec outside the Appalachian Region. Bleakney (1958) considered a report from near the junction of the Ottawa and Gatineau Rivers as rare or dubious. The reports are thought to be based on confusion with the Two-lined Salamander *Eurycea bislineata.* Intensive collecting by Bleakney and others over the past 20 years has failed to turn up *Desmognathus* on either the Ontario or the Quebec side of the Ottawa River. With the exception of a population at St. Hilaire, and another near the International border 50 km south of Montreal W. F. Weller, in preparation), Dusky Salamanders are unknown from the St. Lawrence Lowlands. The Lowlands are relatively flat and the watercourses that cross this plain are slow-moving, silty, and quite warm during the summer. Denman and Lapper (1965) concluded that the Lowlands must have supported interconnecting populations of *D. f. fuscus* at one time but these populations have been extirpated because of 300 years of clearing and agricultural activities.

It appears likely that the distribution of *D. f. fuscus* in Quebec would be restricted to ecologically favorable environments within the Appalachian Region if it were not for the presence of the Monteregian Hills. These hills and their immediate surroundings provide the only habitats between the Appalachian Region and the St. Lawrence River that are suitable for this salamander.

The Monteregian Hills and St. Hilaire Populations

The Monteregian Hills are eight igneous intrusives aligned on an east–west trend which transects the boundary between the Appalachian Mountain System and the St. Lawrence Lowlands. This trend extends from the Eastern Townships to Montreal, a distance of about 80 km. Differential erosion since their emplacement approximately 75 million years ago has left the crystalline intrusives standing conspicuously above the surrounding sediments. The geology of this area has been described by Dresser and Denis (1944).

Brome and Shefford Mountains, the easternmost of the Monteregian inrtusives, are completely within the Appalachian System. Dusky Salamanders have been found in the immediate vicinity of these mountains and undoubtedly occur on them. Yamaska Mountain, which straddles the Appalachian–Lowlands boundary, has yielded specimens of *D. f. fuscus* from its western slopes (I. S. Lapper, personal communication). Mounts Johnson and Rougemont are within the Lowlands. The writer has not collected *Desmognathus* on either of these hills and does not know of any records from these locations. However, suitable environments exist on both hills and the species may be present there. Duskies have been collected from several streams on St. Hilaire Mountain and are quite common where they occur (I. S. Lapper, personal communication). At one time, McGill University's Redpath Museum had a specimen, tentatively identified as *D. f. fuscus,* from St. Bruno Mountain. This specimen has apparently been lost and verification is impossible (N. A. M. Verbeek, personal communication, 16 June 1972). No specimens are known from Mount Royal, the westernmost of the Monteregian Hills. If suitable habitats ever existed on this mountain, they have been severely altered or eradicated.

St. Hilaire is located 32 km east of Montreal and 25 km west-northwest of Yamaska Mountain, the nearest occurrence of *D. f. fuscus.* The

Dusky Salamanders occupy two distinctly different habitats in the St. Hilaire area. On the mountain proper, these salamanders are found in the immediate vicinity of small, fast-moving streams which drain surrounding topographic heights (I. S. Lapper, personal communication). These streams freeze completely during the winter months and the salamanders that live in these environs may be forced to seek lower levels, much as *D. f. fuscus* do in central New York (Hamilton 1943). The other habitat is a spring-fed pond on the St. Lawrence Lowlands 1.1 km west of the mountain. The dates on which observations were made, the measured air and water temperatures, and the number of specimens seen at this location are summarized in Table 1.

The pond is of irregular shape, wider at the southern end than at its effluence to the north (Figure 2). It is 0.4 to 3.1 m wide and 4.3 m long. Well developed humic soil forms the banks while the bottom consists of leaf mulch and organic muck. A profuse growth of algae is usually present at the surface. The pond is fed by a spring which enters from below through fractured shales at the southern end. Water level varies a little through the seasons and is lowest in late summer.

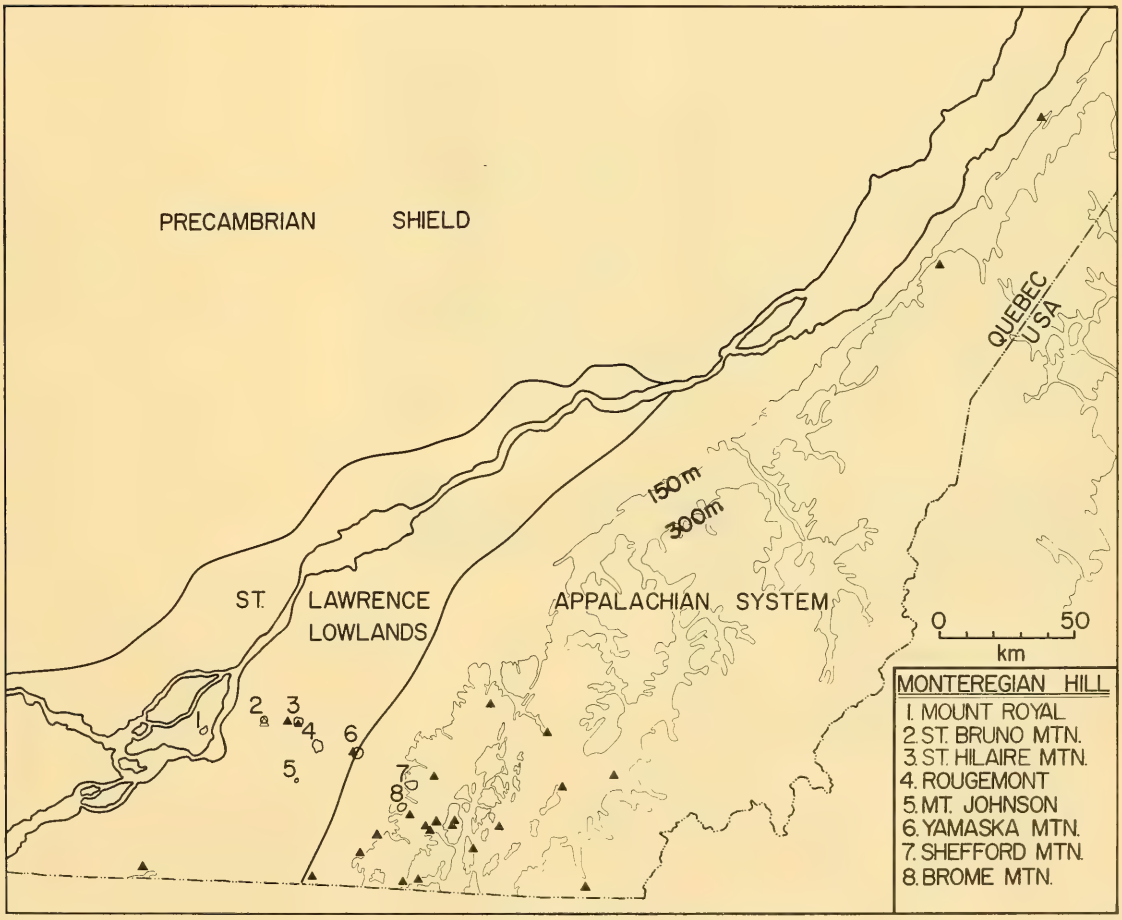

FIGURE 1. Records of the Dusky Salamander *Desmognathus f. fuscus* in Quebec. The open triangle at St. Bruno Mountain represents a possible occurrence that cannot be verified.

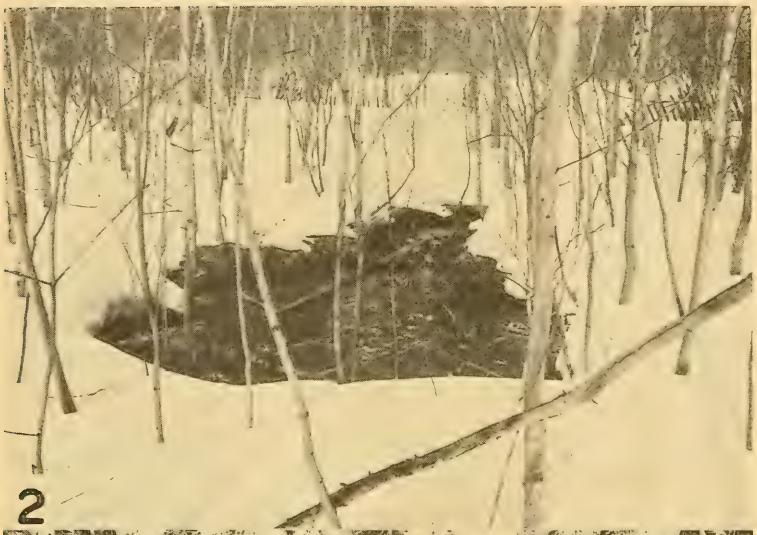

FIGURE 2. The spring-fed pond 1.1 km west of St. Hilaire Mountain, looking north.

FIGURE 3. A portion of the west bank near the effluence of the pond. Duskies were commonly found under the logs in the center of the picture.

Dusky Salamanders are concentrated in the narrow and relatively shallow effluence of the pond where planks, logs, and rocks in damp to wet, or completely submerged situations serve as cover (Figure 3). Of 45 sightings made from 1965 to 1968, 41 were made here. Searches of the pond's deeper southern areas failed to reveal any evidence of the salamander. However, no searches were made at night when the species may be more active. Four specimens were found at distances 4 to 5 m downstream from the pond's exit; none were found at greater distances. The water temperature increases rapidly downstream and cover is lacking. On 19 May 1967 the water temperature at a point 26 m from the exit was found to be 3°C warmer than the water in the pond.

Adult duskies at this location range from 45 to 115 mm in total length. The average snout–vent length is 46 mm for males (N=5), and 45 mm for females (N=4). Only two *D. f. fuscus* larvae have been seen at this location; one of these measured approximately 25 mm.

TABLE 1. — Sightings of Dusky Salamanders in a pond near St. Hilaire on the St. Lawrence Lowlands.

Date	Time	Temperature, °C		Sightings
		Air	Water	
March 7, 1965	NR*	8.0	5.0	5
April 4, 1965	1415	NR	NR	7
April 10, 1965	0945	NR	NR	2
April 10, 1965	1430	9.0	5.0	5
April 30, 1965	1405	28.0	6.5	3
March 5, 1966	1320	5.5	3.0	3
March 19, 1967	1415	−1.0	5.0	3
March 26, 1967	1615	NR	NR	5
April 8, 1967	1730	6.0	5.5	3
April 21, 1967	1130	9.5	6.0	4
May 19, 1967	1540	14.5	6.5	5
Nov. 11, 1967	NR	3.0	9.0	0
Jan. 14, 1968	NR	−10.0	6.5	0

*NR = not recorded.

Many of the St. Hilaire specimens have stump or regenerated tails. The cause of such a high rate of tail loss is unknown but the fact that the tail readily undergoes autotomy was demonstrated when one specimen lost the distal portion as it doubled back on itself and wiggled violently in the writer's hand. A partially digested portion of a Dusky Salamander tail was found in the stomach of another specimen (GBP-8) from this locality.

Representatives of the St. Hilaire population generally agree in appearance with the descriptions published by Cope (1889), Wilder (1913), Dunn (1917), Bishop (1941, 1947), and Conant (1958). However, on 26 March 1967 the writer caught an aberrant specimen that was very similar to the yellow albino recently described by Channell and Valentine (1972).

The specimen, an adult male, measured 99 mm total length, 50 mm snout–vent length. In life the color of the dorsal and lateral surfaces was uniformly bright orange, but with preservation it has faded to a buff color. The area between and in front of the eyes is darker than the rest of the body, and is darkest in the vicinity of the snout. The proximal portion of the tail is also darker than the body to a point 17 mm from the anterior angle of the vent. At this point the tail becomes lighter in color along an irregular contact, and the dorsal keel diminishes in height; regeneration subsequent to loss of the original tail is indicated. The venter is unpigmented to 2 mm on either side of the midventral line, except in the pectoral and pelvic regions where there is minor pigmentation. The chin and ventral surfaces of the limbs are unpigmented, but portions of the toes are dark brown. The ventral surface of the tail is pigmented, but completely lacks melanophores. The aberrant individual is compared to a normal specimen in Figure 4.

Wilder (1913), Hamilton (1943), and others have reported on the wide variety of aquatic and terrestrial organisms preyed upon by the Dusky Salamander. The stomach con-

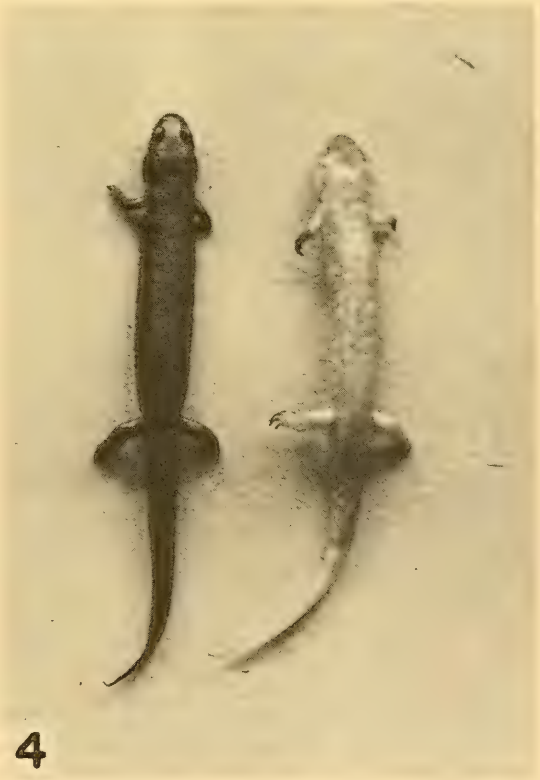

FIGURE 4. An aberrant *Desmognathus f. fuscus* (right) from the pond at St. Hilaire, compared to a normal specimen (left) from the same population.

tents of nine specimens from the spring-fed pond at St. Hilaire were investigated. Empty stomachs were found in four individuals. Several contained abundant plant matter, small wood chips, and grains of sand. Three contained Coleoptera. One female (GPB-2) contained a small unidentified insect. An adult male (GBP-8), with a snout–vent length of 48 mm, was found to contain the partially digested remains of a portion of a tail from another *D. f. fuscus*.

Acknowledgements

The writer is extremely grateful to Mr. F. R. Cook, Curator of Herpetology at the National Museum of Natural Sciences, who provided unpublished distribution data on the specimens in his care. J. S. Bleakney, F. R. Cook, and C. B. Powell read the manuscript and offered several suggestions which contributed to its improvement.

Literature Cited

Bishop, S. C. 1941. The salamanders of New York. New York State Museum Bulletin 324: 1–365.

Bishop, S. C. 1947. Handbook of Salamanders. Cornell University Press, Ithaca, New York.

Bleakney, J. S. 1958. A zoogeographical study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 115: 1–119.

Channell, L. S. and **B. D. Valentine.** 1972. A yellow albino *Desmognathus fuscus* from West Virginia. Journal of Herpetology 6(2): 144–146.

Conant, R. 1958. A field guide to reptiles and amphibians of eastern North America. Houghton Mifflin Company, Boston, Massachusetts.

Cope, E. D. 1889. The Batrachia of North America. United States National Museum Bulletin 34.

Denman, N. S. 1963. A range extension of the Dusky Salamander in Quebec. Canadian Field-Naturalist 77(1): 62.

Denman, N. S. and **I. S. Lapper.** 1965. The herpetology of Mont St. Hilaire, Rouville County, Quebec, Canada. Herpetologica 20(1): 25–30.

Dresser, J. A. and **T. C. Denis.** 1944. Geology of Quebec. Quebec Department of Mines, Geological Report 20, Volume 2.

Dunn, E. R. 1917. The salamanders of the genera *Desmognathus* and *Leurognathus*. United States National Museum Proceedings 53: 393–433.

Hamilton, W. J., Jr. 1943. Winter habits of the Dusky Salamander in central New York. Copeia 1943(3): 192.

Logier, E. B. S. and **G. C. Toner.** 1961. Check list of amphibians and reptiles of Canada and Alaska. Life Sciences Division, Royal Ontario Museum Contribution 53: 1–92.

Wilder, I. W. 1913. The life history of *Desmognathus fusca*. Biological Bulletin 24(4): 251–292; 24(5): 293–342.

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The Breeding Biology of the Great Blue Heron on Tobacco Island, Nova Scotia

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McAloney, K. 1973. The Breeding Biology of the Great Blue Heron on Tobacco Island, Nova Scotia. Canadian Field-Naturalist 87: 137–140.

Abstract. The Great Blue Heron, *Ardea herodias,* begins nesting in eastern Nova Scotia about the same time as reported from southern Alberta but 6 weeks later than reported from western Oregon. Great Blue Herons were found to be in determinate layers and the mean clutch size was 4.17 eggs. Incubation period was determined to be 27.1 days. Thirty-eight breeding pairs initiated 42 nests and fledged an average of 2.84 young per pair from 35 successful nests. Nestling mortality was found to be 8.5% up to 45 days of age. The fledging rate found in this colony is the highest reported for Great Blue Herons.

Introduction

A colony of approximately 40 pairs of Great Blue Herons, *Ardea herodias,* was found on Tobacco Island, Nova Scotia, in 1970. A review of the literature and correspondence with ornithologist Dr. Robie W. Tufts revealed that very little has been done on the breeding biology of herons in the Maritime Provinces. Since other breeding studies (Vermeer 1969; Pratt 1970; Henny and Bethers 1971) had involved mainland colonies in central and western North America, the author decided to study this island colony in eastern Canada. The study was designed to determine egg-laying chronology, clutch size, hatching and fledging success of the Great Blue Heron.

Study Area

Tobacco Island is a 19-acre island situated in the mouth of Gegogan Bay, Guysborough County, Nova Scotia at lititude 45°01′N and 61°55′W. Approximately one-half the island is vegetated with raspberry, *Rubus* sp, amidst standing conifers now dead as a result of the presence of a large colony of Double-crested Cormorants, *Phalacrocorax auritus.* The Great Blue Herons nested on the other half of the island in a mixed stand of balsam fir, *Abies balsamea* (L), and red spruce, *Picea rubens* Sarg., ranging from 20 to 35 feet in height.

Tobacco Island has an abundance of bird life including the colonial species the Great Black-backed Gull (*Larus marinus*), Herring Gull (*Larus argentatus*), and Common Eider (*Somateria mollissima dresseri),* in addition to the cormorants and Great Blue Herons. The two gull species and one pair of Common Crows, *Corvus brachyrhynchos,* were the only predators on the island.

Methods

Nests were located by climbing a tall tree and scanning the trees in the immediate vicinity. A nest tree was marked by placing a numbered aluminum tag on its lowest branch. Observations were made three times per week during the laying period, and twice per week for the remainder of the season. The colony was observed from April 26 until July 28, 1971. An average of 10 observations per nest were recorded with the numbers varying according to the stage of the nesting cycle at the time of nest location. At 5-day intervals young herons were weighed in the nest, using a hand-held balance. A total of 50 weighings as recorded.

Results and Discussion

Nests

In this study 42 nests were observed of which 30 were located in live trees and 12 in dead trees. No appreciable difference was noted in success rate between those nests located in dead trees and those in live trees. In no instance was there more than one active nest per tree. The

nest trees included 39 balsam fir, two red spruce, and one yellow birch. Since the tree species were used as nesting sites in direct proportion to their occurrence on the island, it was concluded that no preference was shown for any tree species.

The height of nests varied from 15 to 35 feet above ground. Henny and Bethers (1971) considered the highest nests to be choice sites as they were used first. However, no correlation was found between nest height and date of nest initiation on Tobacco Island. Tuft (1961) described the nest as a platform of sticks sometimes lined with finer twigs. Thirty-four nests were of the above description, while the remaining eight were lined with miscellaneous materials, including grass, rockweed, green fir boughs, raspberry stalks, bur-reed, and rope. Bent (1926) described new nests as being very frail and shallow while nests which had been used in previous years were larger, thicker, and had an accumulation of filth in them and on the trees. On the above basis, the 42 nests were classified as 25 old nests and 17 new nests. Five of the six nests which lost all eggs before incubation were new nests which failed to withstand early season windstorms.

Egg-laying Chronology, Interval and Clutch Size

First visits to the nests revealed 22 nests in the laying stage, 18 being incubated, one with destroyed eggs, and one with half-grown young. The last was isolated from the rest of the colony and was not detected until excrement from the young had "whitewashed" the ground beneath the tree. Actual observations and back-dating from hatching times showed the peak of clutch initiation to be the first week of May (Table 1).

TABLE 1. — Initiation of egg-laying of 40 Great Blue Heron clutches on Tobacco Island, 1971.

Week of first egg	No. nests
April 18 – April 24	1
April 25 – May 1	7
May 2 – May 8	19
May 9 – May 15	9
May 16 – May 22	3
May 23 – May 29	1

The first eggs were laid on April 20, 1971, and the last on June 4, 1971. The "first egg" date is similar to that of Alberta (Vermeer 1969) but 6 weeks later than in western Oregon (Henny and Bethers 1971).

The rate of egg laying could be determined in 13 nests. In 12 nests, the eggs were laid at 2-day intervals, which is the usual interval for herons (Pratt 1970). In one clutch of three, the eggs were laid at 3-day intervals.

The clutch size for 36 incubated clutches averaged 4.17 and ranged from 3 to 6 eggs (Table 2).

TABLE 2. — Clutch size of 36 incubated nests.

No. nests	No. eggs
8	3
16	4
10	5
2	6
Mean clutch size	4.17

Egg Loss and Indeterminate Laying

A total of 32 eggs was lost, of which 25 were from incomplete clutches and 7 from complete clutches. Windstorms caused the loss of 21 eggs, while 11 were lost to predators. Bent (1926) lists gulls, crows, and ravens as predators on heron nests. Crows were considered to be the predators on Tobacco Island, as the destroyed eggs were punctured in a manner similar to that of eider eggs known to be preyed upon by crows.

Egg losses provided information on the laying capacity of the female heron. All eggs from four nests in the laying stage were lost because of windstorms. The result was two second attempts, one clutch of three being laid in one of the nests and another clutch of three being laid in a new nest constructed in the nearest tree to the destroyed nest. Young successfully hatched in those two nests but were the latest in the colony. Two other clutches hatching that same week (June 17–23) were

also thought to be second attempts. Where eggs of an incomplete clutch were lost, laying continued until a full complement was reached. Data from our such nests showed that a total of 27 eggs (6.75 per female) as laid, in order that 17 (4.25 per female) could be incubated. Judged by those observations, Great Blue Herons appear to be indeterminate layers.

Incubation Period and Duration of Hatching

Bent (1926) stated that the incubation period for herons was 28 days, while Vermeer (1969) found it to be 26.7 days. However, neither author defined 'incubation period.' Although Welty (1962) stated that herons began incubating after the first egg was laid, I found that two young herons usually hatched the same day, and others followed at 1 to 2-day intervals. Incubation period was defined as the time elapsed from the laying of the last egg until the hatching of the last young when all eggs had hatched. Based on observation of 11 nests, the incubation period was found to be 27.1 days with a range of 25 to 30 days.

The duration of hatching averaged 3 days with a range of 2 to 6 days, larger clutches taking longer. Pratt (1970) recorded similar results for Great Herons in California.

Hatching Success

Thirty-six of the 37 incubated nests hatched at least one young. The exception was a nest which was incubated for 35 days and then abandoned. Subsequent examinations of the four eggs of that nest revealed them to be infertile. Hatching success of the 155 incubated eggs was 75% (118 eggs) while 20% (30 eggs) failed to hatch, and 5% (7 eggs) were lost because of wind or predators. Pratt (1970) found a hatching success of 84% for herons in central California.

Nestling Growth and Development

The adults brooded the young constantly for the first 2 weeks after hatching. During this time the young protested vigorously if exposed to the elements. Thereafter, the young were quiet unless disturbed during nest checks. At the age of 2 weeks the young could move about in the nests and by 3 weeks they could defend themselves with their beaks when they were handled.

The young herons were first observed on branches outside the nest at 35 days of age. Short "hopping" flights were made at 40 days and 10 broods left the nest at an average age of 45 days. Vermeer (1969) found 52.6 days to be the age of first flight, while Pratt (1970) observed hopping flights at 42 days and sustained flights at 60 days. The young on Tobacco Island were observed about the colony for an additional 10 days, being fed by the adults. Table 3 gives the weights of young herons at 5-day intervals.

Table 3. — Weights of 50 young Great Blue Herons on Tobacco Island, 1971.

Age, in days	No. weighed	Mean weight, in grams
1	4	86.1
5	5	170.1
10	8	567.0
15	6	982.5
20	5	1114.8
25	6	1441.1
30	7	1593.3
35	5	1786.1
40	4	2055.4

Fledging and Overall Reproductive Success

Forty-two active nests hatched 118 young, of which 108 lived to 45 days of age and were considered fledged. The mean number of

Table 4. — Fledging success of Great Blue Heron on Tobacco Island, 1971.

No. nests*	No. fledgings per active nests
7	0
1	1
4	2
22	3
7	4
1	5
Totals 42	108

*Includes four probable replacements so that eight of the nesting attempts were made by four pairs.

TABLE 5. — A comparison of reproductive success for the Great Blue Heron.

Location and latitude	Years	Clutch size	Percent of nests successful	Number young fledged per successful nest	Number young fledged per nesting pair[1]	Source
Southern Alberta (49°–55°)	1967–68	5.00 (11)[2]	—	2.51	2.2–2.3	Vermeer (1969)
Eastern Nova Scotia (45°)	1971	4.17 (36)	81	3.09	2.84	This paper
Western Oregon (44°)	1970	4.19 (32)	78	2.61	2.04	Henny and Bethers (1970)
Central California	1967–68	3.66 (41)[3]	76—82	—	1.5–1.7	Pratt (1970)

[1]Includes pairs which were unsuccessful in their attempt to produce young.
[2]Sample size in parentheses.
[3]From Henny and Bethers (1970).

fledglings per active nest was 2.57 with a range of 0–5 (Table 4). The mean numbers fledged per nesting pair and per successful nest were 2.84 and 3.09 respectively. The 10 young that died in the nest included nine which were the last to hatch in their respective nests. Those chicks died of starvation between 1 and 16 days of age. One 25-day-old heron which appeared healthy, died of a punctured cranium thought to have been inflicted by a brood mate. Nestling mortality was 8.5% compared to 30 and 45% for 2 years in California (Pratt 1970). In that study, most of the mortality occurred during the third and fourth weeks when competition for food was greatest.

Table 5 compares the overall reproductive success of Great Blue Herons in Alberta (Vermeer 1969), California (Pratt 1970), and Oregon (Henny and Bethers 1971) with that of Tobacco Island, Nova Scotia.

Conclusion

The Great Blue Herons on Tobacco Island achieved high reproductive success in 1971, and barring abnormally high mortality rates, should increase.

Acknowledgements

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Literature Cited

Bent, A. C. 1926. Life histories of North American marsh birds. United States National Museum Bulletin 135.

Henny, C. J. and **M. R. Bethers.** 1971. Ecology of the Great Blue Heron with special reference to Western Oregon. Canadian Field-Naturalist 85: 205–209.

Pratt, H. M. 1970. Breeding biology of Great Blue Herons and Common Egrets in Central California. Condor 72: 407–416.

Tufts, R. W. 1961. The birds of Nova Scotia. Nova Scotia Museum, Halifax, N.S. 481 pp.

Vermeer, K. 1969. Great Blue Heron colonies in Alberta. Canadian Field-Naturalist 83: 237–242.

Welty, J. 1962. The life of birds. W. B. Saunders Company, Philadelphia and London. 546 pp.

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Studies on the Bryophytes of Southern Manitoba. II. Collections from the Winnipeg Area

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Stringer, M. H. L. and P. W. Stringer. 1973. Studies on the Bryophytes of Southern Manitoba. II. Collections from the Winnipeg Area. Canadian Field-Naturalist 87: 141–144.

Abstract. Fifty-five taxa of bryophytes are reported for the area of Winnipeg, Manitoba. *Frullania inflata, Brachythecium acuminatum, Encalypta ciliata,* and *Tortella inclinata* are new records for the province.

Little work has been done on the bryophyte flora of Manitoba, and published work on the ecology of mosses and liverworts of the area lags far behind that for many other provinces. This is especially unfortunate as Manitoba lies in the transition zone of three major vegetation formations: the Boreal forest, the prairies, and the St. Lawrence-Great Lakes forest. It is consequently floristically rich and merits further study.

In recent years, Bird (1962, 1969) has recorded a number of bryophyte species from the prairies and the Aspen Parkland, including some collections from the Winnipeg area. Longton (1972) published 19 new records, mostly from the northern part of the province.

The present paper in which 55 species are recorded, is part of a series on the ecology and distribution of the bryophytes of southern Manitoba.

The area studied (49°43′-50°05′ N, 97°00′-97°20′ W) lies wholly within the Aspen Parkland (Bird 1961) and its forests are almost wholly deciduous. The nearest coniferous forests are at Birds Hill Provincial Park, 24 km NNE of the city. The bryophyte flora of this latter area will be the subject of other publications in this series (in preparation).

Most of the upland region in the Winnipeg area is occupied by aspen *(Populus tremuloides)**–oak *(Quercus macrocarpa)* forest, while the valleys of the Red, Seine, Assiniboine, and La Salle rivers are lined with floodplain forest dominated by green ash *(Fraxinus pennsylvanica),* Manitoba maple *(Acer negundo),* and elm *(Ulmus americana),* with basswood *(Tilia americana)* locally abundant.

*Vascular nomenclature follows Scoggan 1957.

Collections were made in eleven areas between June and August 1972, as follows.

1. North Kildonan Park, on clay and stones beside lake 8 km NNE of downtown Winnipeg.
2. La Barrière Park, in oak–aspen and floodplain forest along the La Salle river 16 km S of downtown Winnipeg.
3. St. Vital Park, in oak–elm–maple forest, merging into oak–aspen. On east bank of Red River, 6.4 km S of downtown Winnipeg.
4. Seine River bank at Marion Street. Ash–elm–maple forest with the understorey partly cleared.
5. Camp Manitou, 16 km W of downtown Winnipeg. Extensive areas of medium-aged — old deciduous forest in a bend of the Assiniboine River. Floristically the richest area, with moss abundant on deadfall and on live trunks.
6. Seine River bank in southeast Winnipeg, just N and S of Highway No. 1. Moss mostly on trunks of deciduous trees.
7. Assiniboine Park on south bank of Assiniboine River. Much of the area has been cleared, but extensive areas of only slightly disturbed forest of all types remain.
8. Very disturbed open grassland behind Cottonwood Village, 0.8 km N of Highway No. 1 and 2.4 km E of the Seine River.
9. Stony Mountain 0.8 km SE of the village of Stony Mountain, 24 km N of downtown Winnipeg. A large limestone outcrop, disturbed by quarrying. Dense *Salix* sp. shrubs on the west side, and a calcareous marsh on the northwest side.
10. Crescent Drive Park. Across the Red River from area 3, and with a similar type of forest.
11. Ash–elm–oak forest sloping rapidly to the river, on the south bank of the Assiniboine River just E of Assiniboine Park.

The numbers in brackets in the following list refer to the areas described above. Nomenclature of mosses follows Crum *et al.* (1965) with modification according to Crum (1971). Hepatic nomenclature follows Schuster (1953) with abbreviations of authorities modified to conform with the list given by Sayre *et al.* (1964).

Taxonomic and field work were shared equally by both authors. Voucher specimens have been deposited in the authors' own herbarium and at the University of Winnipeg.

When possible, several collections of the same species were made in each area, and the comments on substrates and associated species are based on careful observation of all collections made.

Hepaticae

Frullania inflata Gott. (5). Not previously recorded for the province. A single collection of this species in fruit was made 0.5 m above the ground on the south and east sides of an elm tree, where it was growing with *Pylaisiella polyantha* and *Brachythecium* sp. According to Schuster (1953) this species is not rare on bark in elm floodplain forests.

Marchantia polymorpha L. (1, 7, 8). Fairly common on soil in moist habitats in the area. Often with *Leptobryum pyriforme* or *Leptodictyum trichopodium* var. *kochii*.

Musci

Amblystegium juratzkanum Schimp. (2, 3, 4, 5, 9, 10, 11). Common on tree bases, with *Brachythecium salebrosum* and *Mnium cuspidatum*, but also found on silt and clay in floodplain forest with *Leptodictyum* spp. (2, 11).

Amblystegium serpens (Hedw.) B.S.G. (2, 3, 9, 11). In the same habitats as the preceding species but less often on silt.

Amblystegium varium (Hedw.) Lindb. (2, 3, 5, 9, 10). Frequent on rotten wood, or on moist clay (3), and often forming pure mats.

Anomodon minor (Hedw.) Fürnr. (2, 3, 4, 10, 11). A characteristic species of tree bases in the area, occurring on all species except aspen, and sometimes extending up to 30 cm up the trunk in situations where moisture seems more abundant than usual. It is often associated with the basal *Mnium* and *Brachythecium* colonies and higher up the trunk with *Leskea* spp.

Brachythecium acuminatum (Hedw.) Rau and Herv. (2, 3, 5). Occupying the same niche as *B. salebrosum* on humus at tree bases. Sterile material was determined with difficulty in some cases. A new recording for the province.

Brachythecium campestre (C. Müll.) B.S.G. (3, 5). Usually on humus in drier areas. Several collections were in fruit and easily distinguished from *B. salebrosum* by the roughness of the upper parts of the seta.

Brachythecium collinum (Schleich. *ex* C. Müll.) B.S.G. (4, 5). A species of drier areas, both collections being made at dry, south-facing tree bases.

Brachythecium rutabulum (Hedw.) B.S.G. (2, 3, 5, 10). On moist humus, sometimes with *Mnium cuspidatum* and *Campylium hispidulum*, or on bottomland silt and clay with *Amblystegium* spp.

Brachythecium salebrosum (Web. and Mohr) B.S.G. (1, 2, 3, 5, 7, 9, 10, 11). The most widespread and commonest member of the genus, occurring in a wide variety of habitats but most frequent on humus and bases of trees of all species. Often associated with *Mnium cuspidatum* at tree bases, or with *Pylaisiella polyantha* higher up the trunks.

Bryum angustirete Kindb. *ex* Mac. (9). One collection made on dry gravelly soil.

Bryum argenteum Hedw. (7, 9). On dry, coarse soil (9) and in cracks in paving stones.

Bryum creberrimum Tayl. (2, 3, 5, 9). On humus, especially in drier open areas, where it is often mixed with *Ceratodon purpureus*. Widespread and common in the area.

Bryum pallescens Schleich. *ex* Schwaegr. (2). One collection only, at the base of an oak, on humus.

Bryum stenotrichum C. Müll. (9). Two collections, on humus, and on rotten wood with *Brachythecium salebrosum* and *Amblystegium varium*.

Callicladium haldanianum (Grev.) Crum (5, 11). Both collections on moist rotten wood, one with *Mnium cuspidatum*. Previously reported for the Winnipeg area by Bird (1969) and for the Spruce Woods area by Bird (1969) and by the authors[1].

Campylium chrysophyllum (Brid.) J. Lange (3, 9). On thick humus and rotten wood in moist habitats. Not common.

Campylium hispidulum (Brid.) Mitt. (2, 3, 5, 9). Common on tree bases, with *Amblystegium juratzkanum*, and on rotten wood with *Haplocladium microphyllum*.

Campylium stellatum (Hedw.) C. Jens. (8). One collection made with *Leptodictyum riparium* and *Drepanocladus aduncus* in a grassy area flooded in spring.

Ceratodon purpureus (Hedw.) Brid. (2, 3, 4, 5, 7, 9). A widespread and common species, occurring with a wide variety of associated species, notably *Bryum* spp. in dry habitats, and on a wide variety of substrates, ranging from clay and silty gravel (2, 3, 4) to such unusual substrates as a piece of polythene foam sponge with a little humus on it (3).

Climacium dendroides (Hedw.) Web. and Mohr (5). One collection, on humus and hardwood litter under oak.

Dicranella varia (Hedw.) Schimp. (9). Two collections, both on silt in the marshy area at this site.

Dicranella grevilleana (Brid.) Schimp. (3). One collection, on silty soil, with *Leptodictyum riparium*.

[1]Stringer, M. H. L. and P. W. Stringer. Studies on the bryophytes of southern Manitoba. I. Collections from Spruce Woods Provincial Park. In preparation.

Ditrichum flexicaule (Schwaegr.) Hampe (9). In thick sods, on coarse, gravelly soil in cracks in the rock outcrop.

Drepanocladus aduncus (Hedw.) Warnst. (8). This wetland species was found only in grassland flooded in spring.

Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. *ex* Voit) Roth (3, 9, 12). More commonly found than the preceding, this variety was also collected in wet areas (e.g. marsh (9)), on humus or clay.

Drepanocladus vernicosus (Lindb. *ex* C. Hartm.) Warnst. (9). Found only as pure masses in the calcareous marsh at Stony Mountain.

Encalypta ciliata Hedw. (2, 3). Usually found on clay in dry areas. Not previously recorded for the province.

Eurhynchium pulchellum (Hedw.) Jenn. (2, 5). In pure mats, often on humus at tree bases.

Funaria hygrometrica Hedw. (1, 5, 7, 10). Common on ashes of old fires but also on clay (1). Frequently with *Leptobryum pyriforme* and *Bryum* spp.

Grimmia apocarpa Hedw. var. *conferta* (Funck) Spreng. (9). A saxicole, found twice on bare limestone.

Haplocladium microphyllum (Hedw.) Broth. (3, 5, 7, 9, 11). Common, especially in area 5, but confined to moist, well-rotted wood where its commonest associates were *Mnium cuspidatum* and *Leptodictyum trichopodium* var. *kochii*.

Hypnum lindbergii Mitt. (5). One collection, on black silt over rotten wood in a wet hollow with *Leptodictyum riparium*.

Leptobryum pyriforme (Hedw.) Wils. (1, 4, 5, 7). Common on a wide range of substrates but most frequently on clay or soil.

Leptodictyum riparium (Hedw.) Warnst. (2, 3, 4, 5, 11). Frequent on litter or silt and clay in wet habitats.

Leptodictyum trichopodium (Schultz) Warnst. var *kochii* (B.S.G.) Broth. (1, 2, 3, 5, 7, 9, 11). Common especially on moist silt and clay, but also on rotten wood (1, 2, 3, 5) with *Haplocladium*.

Leskea obscura Hedw. (2, 3, 4, 10). Most frequently on bark near bases of live trees but persisting on bark on deadfall until decay is well advanced. Commonly associated with *Anomodon, Pylaisiella,* and *Orthotrichum* spp.

Leskea polycarpa (Hedw.) (2, 3, 4, 5, 7, 11). In the same habitats as, but more frequent than, the preceding species. The two species are distinguished with difficulty (Bird 1969), *L. polycarpa* having the more acute leaves.

Leskeela nervosa (Brid.) Loeske (9). Two collections made, with *Amblystegium juratzkanum, Mnium cuspidatum,* and *Brachythecium salebrosum,* on humus and twigs under willow shrubs.

Mnium cuspidatum Hedw. (2, 5, 9, 11). On humus, especially at tree bases, but also on rotten wood.

Orthotrichum obtusifolium Brid. (2). On bark of a live elm tree at the edge of a floodplain forest, with *Leskea obscura*.

Orthotrichum pumilum Sw. (2, 3, 10). On bark of live trees above basal stockings and often for several meters up the trunk. Especially common on poplar.

Plagiomnium rugicum (Laur.) Koponen (7). On wet, sandy soil with *Brachythecium salebrosum* and *Pohlia wahlenbergii*. Nomenclature follows Koponen (1971).

Platygyrium repens (Brid.) B.S.G. (2, 9, 11). On clay soil (2, 11) and limestone rock (9). Juvenile specimens were distinguished with difficulty from *Pylaisiella polyantha*.

Pohlia wahlenbergii (Web. and Mohr) Andr. (7). One collection, on wet, sandy soil at the edge of a pond.

Pylaisiella polyantha (Hedw.) Grout (2, 3, 5, 9, 10). A characteristic corticolous species, occurring above the basal *Mnium–Brachythecium* stockings but persisting for some time on deadfall, where it was found several times with *Haplocladium*.

Rhynchostegiella compacta (C. Müll.) Loeske (9). One collection, on twigs and litter under willow shrubs.

Thuidium recognitum (Hedw.) Lindb. (5). One collection, on loose humus and litter, under oak.

Tortella fragilis (Hook. *ex* Drumm.) Limpr. (9). Common on coarse soil on the limestone outcrop.

Tortella inclinata (Hedw. f.) Limpr. (9). One collection, on thick humus over coarse, gravelly soil. Not previously recorded for the province.

Tortella tortuosa (Hedw.) Limpr. (9). Common in the same habitat as the preceding species.

Tortula mucronifolia Schwaegr. (2). One small collection, on bare soil in an oak wood, with *Encalypta ciliata*.

Tortula ruralis (Hedw.) Gaertn., Meyer and Scherb. (9). On coarse soil over limestone rock. Not common.

Weissia controversa Hedw. (9). On coarse soil in a crack in limestone rock. One collection only.

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Literature Cited

Bird, C. D. 1962. Mosses of the prairies of west-central Canada. Canadian Journal of Botany 40: 35–47.

Bird, C. D. 1969. Bryophytes of the aspen parkland of west-central Canada. Canadian Journal of Botany 47(1): 187–212.

Bird, R. D. 1961. Ecology of the aspen parkland of western Canada. Publication 1066, Canada Department of Agriculture, Research Branch, Ottawa.

Crum, H. 1971. Nomenclatural changes in the Musci. Bryologist 74: 165–174.

Crum, H., W. C. Steere and **L. E. Anderson.** 1965. A list of the mosses of North America. Bryologist 68: 377–434.

Koponen, T. 1971. A monograph of *Plagiomnium* sect. Rosulata (Mniaceae). Annales Botanici Fennici 8: 305–367.

Longton, R. E. 1972. Nineteen bryophytes new to Manitoba. Bryologist 75: 348–350.

Sayre, G., C. E. B. Bonner and **W. L. Culberson.** 1964. The authorities for the epithets of mosses, hepatics, and lichens. Bryologist 67: 113–135.

Schuster, R. M. 1953. Boreal Hepaticae, a manual of the liverworts of Minnesota and adjacent regions. American Midland Naturalist 49(2): i–v, 257–684.

Scoggan, H. J. 1957. Flora of Manitoba. Bulletin 140, National Museum of Canada, Ottawa.

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Ecology of the Woodland Jumping Mouse (*Napaeozapus insignis*) in New Hampshire

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Lovejoy, D. A. 1973. Ecology of the Woodland Jumping Mouse *(Napaeozopus insignis)* in New Hampshire. Canadian Field-Naturalist 87: 145–149.

Abstract. Population densities of the woodland jumping mouse (*Napaeozapus insignis*) were studied on logged over and control sites in east-central New Hampshire from May 1968 to December 1969 by live-trapping and snap-trapping. Largest numbers were captured on the older (> two years) seral stages and on certain moist uncut areas. Highest population densities occurred where there was low woody vegetation cover, high soil moisture, and abundant invertebrate food. The suggestion that *N. insignis* is excluded from suitable habitat by competition from the redback vole *(Clethrionomys gapperi)* is discussed.

Introduction

As part of an ecological study of small mammal succession following logging in the White Mountain National Forest in New Hampshire (Lovejoy, 1970), observations were made on certain aspects of the ecology of the woodland jumping mouse *(Napaeozapus insignis).* Data were collected by snap-trapping and live-trapping on six study areas in east-central New Hampshire.

A rectangular plot (0.7 to 2.6 ha.) gridded at a 10 m interval was placed in each study area. The areas were live-trapped for 8-10 days at approximately bimonthly intervals during the snow-free months from May 1968 to December 1969. Wooden multiple catch traps (Burt, 1940) baited with cracked corn were used throughout. Individuals were marked by toe-clipping and released at the point of capture.

Snap-trapping transects located within 250 m of the live-trap grids and on other seral stages provided additional data. Transects usually consisted of 25 stations (two traps per station) spaced at 10 m intervals. Peanut butter sprinkled with oats was used as bait. Each transect was trapped concurrently with the adjacent live-trapping plot for three consecutive days.

Data were also collected concerning the vegetation (particularly as it relates to the provision of food and cover for small mammals) and invertebrate food supply (litter samples processed in Berlese funnels). Microclimate data (air temperature, relative humidity, soil temperature, and soil moisture) were obtained using maximum-minimum thermometers, continuously recording thermographs and hygrothermographs, and a tele-thermometer (see Lovejoy, 1970, for methods and results of the habitat analysis).

Description of Study Areas

The six areas selected for live-trapping were in the northern hardwood forest region (Lull, 1968) at elevations of 430-560 m. Dominant tree species included beech *(Fagus grandifolia),* yellow birch *(Betula lutea),* and sugar maple *(Acer saccharum).* The areas included four post-logging seral stages, an uncut control, and a 3-4 year old burn. All areas were on northeast facing slopes except the 3-4 year stage and the burn which faced southeast.

0-1 Year Stage. Before logging, this area consisted primarily of mature hardwoods and softwoods with beech, sugar maple, yellow birch, and red spruce *(Picea rubens)* as the most abundant species. A locally variable shrub stratum included the above species and hobblebush *(Viburnum alnifolium),* while the ground stratum included seedlings of the above tree species and starflower *(Trientalis borealis).* This area was live-trapped twice before logging occurred in October 1968. Following logging, the area

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consisted of a mosaic of slash piles, scattered slash, open spaces nearly devoid of low vegetation, skid trails with exposed mineral soil, and islands of uncut or partially cut forest. In the first post-logging growing season, the ground stratum increased greatly in localized areas, but remained less dense than that on the 1-2 year stage; this reflected the different dates of logging on the two areas.

1-2 Year Stage. Before logging, this area was similar to the 0-1 year stage except for larger numbers of beech in all strata. This difference was due primarily to the relatively drier conditions. Logging occurred in June 1968. In general, habitat conditions were similar to those of the 0-1 year stage, but more slash remained owing to less efficient utilization of timber.

3-4 Year Stage. Before logging, this area consisted largely of red spruce and balsam fir *(Abies balsamea)* with smaller numbers of hardwoods. Heavy logging in the spring and summer of 1965 left only a few seed trees on the area. Two major groupings of vegetation occurred on the live-trap grid: (1) A hardwood area which was dominated by a dense growth of sugar maple (2-4 m high) with small numbers of several other woody species and a sparse ground stratum, (2) A *Rubus* area which was dominated by raspberry *(R. idaeus)* and blackberry *(R. allegheniensis)* with small numbers of young hardwoods (1-3 m high). Both groupings contained abundant slash which was generally covered by vegetation.

Burn. In July 1965, 14 ha. of the above logged area was heavily burned, leaving most of the area almost devoid of slash and doing variable damage to the humus. A mosaic of several vegetation types occurred on this area owing to different intensities of burning. These varied from heavily burned sites supporting a dense growth of bracken fern *(Pteridium aquilinum)* to lightly burned sites supporting saplings of fire cherry *(Prunus pensylvanica)* (2-3 m high) and a variable ground cover including bristly sarsaparilla *(Aralia hispida),* twisted stalk *(Streptopus amplexifolius),* and raspberry, among other species.

15-16 Year Stage. Before logging in 1953, this area supported mature hardwoods. During the study, the tree stratum consisted of a relatively uniform dense growth of beech, yellow birch, sugar maple, and moosewood *(Acer pensylvanicum)* (6-8 m high), with most individuals less than 7.5 cm dbh. A sparse ground stratum consisted primarily of seedlings of beech, sugar maple, moosewood, hobblebush, and red spruce.

Control. The tree stratum consisted of mature beech, yellow birch, sugar maple, red spruce, and hemlock *(Tsuga canadensis).* A sparse shrub stratum included large numbers of beech, while the sparse ground stratum (variable locally) was mostly beech and sugar maple seedlings. Few fallen logs were present, but surface boulders were abundant in some sites.

Results

A total of 105 individuals were live-trapped 163 times during the study. An additional 208 individuals were snap-trapped. Highest population densities of *N. insignis* occurred on moist uncut areas or on those logged areas supporting dense cover in the form of low woody vegetation (3-4 year stage, 15-16 year stage; Table 1). The Burn, recently logged areas, and dry uncut areas supported low populations of this species. In snap-trapping on the 3-4 year stage, most captures were recorded in a dense growth of *Rubus* sp., hardwoods, or in decaying slash piles; *N. insignis* was not taken in partially cut sites with little slash and a sparse shrub stratum. In June 1969, 18 *N. insignis* were snap-trapped in slash and dense shrubs on the 3-4 year stage (24 stations) while only one was taken in a partially cut area (11 stations). Similar results were obtained in other snap-trapping periods but smaller numbers were taken. Relatively low populations were indicated by live-trapping of the 3-4 year stage; competition from the redback vole *(Clethrionomys gapperi)* appeared to be a factor on these sites (see below).

These results support the findings of Brower and Cade (1966) who reported *N. insignis* to select areas with a substantial cover of low woody vegetation. Other workers have reported

TABLE 1. — Relative abundance of *Napaeozapus insignis* on several uncut and logged areas, 1968–1969

Stage[1]	Snap-Trapping			Live-Trapping		
	Trap-Nights	Individuals Captured	Captures per 100 TN	Trap-Nights	Individuals Captured	Captures per 100 TN
1–2 year[2]	1701	24	1.4	5201	19	0.37
3–4 year	1078	34	3.1	1400	2	0.14
15–16 year	761	27	3.5	3987	21	0.53
Uncut 0–1 year[3] (Moist)	1391	45	3.2	1696	48	2.83
Control (Uncut-Dry)	1631	7	0.4	3835	14	0.36
Burn	409	1	0.2	2150	1	0.05

[1]Area of each live-trap grid: 1-2 year, 1.2 ha.; 3-4 year, 0.7 ha.; 15-16 year, 2.6 ha.; 0-1 year, 2.1 ha.; Control, 2.6 ha.; Burn, 1.2 ha.
[2]Composit of data from the 1-2 year stage and the 0-1 year stage in 1969 (one year after logging).
[3]1968 data only (before logging).

an association of this species with water (Snyder, 1924; Hamilton, 1943; Preble, 1956; Whitaker, 1963; Wrigley, 1969). In the present study, standing water was not necessary for the presence of this species, but larger numbers were captured in moist than in dry areas. Snap-trapping of several uncut areas indicated *N. insignis* to be more abundant in moist sites; 43 of 47 captures occurred at such sites ($\chi^2 = 12.71$, $p < .0005$, d.f. $= 1$). Snap-trapping of the 15-16 year stage yielded 9 of 10 captures within 10 m of standing water in 1968; only two of 15 captures occurred at similar sites in 1969, a year of above average moisture.

In 1969, *N. insignis* was generally more widely distributed and abundant on all areas except the relatively moist 0-1 year stage than in 1968. The winter of 1967-8 was one of below normal precipitation (data from Pinkham Notch, 6-21 km from the live-trap grids); in addition, rainfall between May and October 1968 was below normal in each month except June; there was a total deficit of 13 cm during this period (U.S. Dept. Comm., 1968). In the following year, the water content of the snow pack was the greatest on record at Pinkham Notch (U.S. Dept. Comm., 1969) and rainfall was 9 cm above normal from May to September 1969. Therefore, the heavier snowfall in the winter of 1968-9 and above normal precipitation during the summer resulted in relatively higher soil moisture during the second year.

Those areas supporting the largest numbers of *N. insignis* (3-4 and 15-16 year stages, 0-1 year stage before logging) provided a moderate to high invertebrate food supply (Lovejoy, 1970). In addition, the 0-1 year stage (before logging) and 15-16 year stage provided conditions suitable for the growth of *Endogone* and other soil fungi (high soil moisture and organic material; Williams and Finney, 1964). Several workers have reported or suggested *Endogone* may be important in the diet of *N. insignis* (Whitaker, 1962, 1963; Williams and Finney, 1964; Getz, 1968). Whitaker (1963) found *Endogone* to be the single most important food of *N. insignis* in New York; he reported (1962) this fungus to make up 32% (by volume) of the food of 16 *N. insignis* from Coos and Carroll Counties, New Hampshire.

In this study, the presence and abundance of *Endogone* was not determined, but moist areas such as the 0-1 and 15-16 year stages probably had relatively large amounts of this fungus. The 3-4 year stage (which also supported large numbers of *N. insignis*) was less moist, but this area provided more food in the ground and shrub strata (including *Rubus* berries) and more invertebrates than did the other two

areas. Invertebrates, seeds, and fruits have been reported to be important food items for *N. insignis* (Burt, 1957; Whitaker, 1963).

The above data indicate cover, food, and soil moisture to be important and interrelated factors affecting the distribution and abundance of *N. insignis* in central New Hampshire. Air temperature, soil temperature, and relative humidity were not important factors influencing the distribution or abundance of *N. insignis* in this study (Lovejoy, 1970).

Competition with the redback vole *(Clethrionomys gapperi)* also appears to have influenced the distribution and abundance of *N. insignis* on some areas. On recently logged sites, slash piles provided conditions favorable for *N. insignis* since they provided adequate food, cover, and soil moisture. Those few individuals captured on recently logged areas were taken in slash piles or in dense woody sites; *C. gapperi* also selected slash piles and was more abundant than *N. insignis* on recently logged areas (Lovejoy, 1970).

Brower and Cade (1966) have suggested (on the basis of temperament of the two species) that *N. insignis* may avoid areas inhabited by *C. gapperi*. Large numbers of both species could not therefore co-inhabit recently logged areas in which their preferred habitat was restricted to small localized sites (slash piles); *N. insignis* would be excluded from these areas by *C. gapperi*.

Of 19 *N. insignis* live-trapped on the two recently logged areas, 12 were taken on the 0-1 year stage in September 1969, one year after logging. By this time, a developing ground stratum was providing more optimal sites for both species throughout the area; as more suitable habitat became available, the species could coexist with less competition. On the 3-4 year stage, large areas of suitable habitat for both species occurred. Large numbers of both species did not occur together in this stage, however; snap-trapping transects generally yielded large numbers of only one of the two species (Table 2), while large numbers of *C. gapperi* and only two *N. insignis* were live-trapped on this area during the study. Similar results were obtained on other areas. Since no differences in type or abundance of cover, moisture, food, microclimate, or vegetation type appeared to exist within or among these areas, exclusion of *N. insignis* from certain sites by a more aggressive *C. gapperi* appears to be the most likely explanation.

TABLE 2. — Captures of *Napaeozapus insignis* and *Clethrionomys gapperi* on snap-trapping transects on the 3–4 year post-logging stage

Date	Trap Nights	*Clethrionomys* captures	*Napaeozapus* captures
July 68	72	6	0
May 69	78	3	0
June 69	210	2	19
July 69	102	12	5
July 69	166	11	1
Aug 69	150	8	1
Aug 69	150	2	7
Aug 69	150	3	1

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Literature Cited

Burt, W. H. 1940. Territorial behavior and populations of some small mammals in southern Michigan. Miscellaneous Publications Museum Zoology University of Michigan 45: 1-58.

Burt, W. H. 1957. Mammals of the Great Lakes Region. University of Michigan Press. Ann Arbor.

Brower, J. E. and **T. J. Cade.** 1966. Ecology and physiology of *Napaeozapus insignis* (Miller) and other woodland mice. Ecology 47: 46-63.

Getz, L. L. 1968. Influence of water balance and microclimate on the local distribution of the redback vole and white-footed mouse. Ecology 49: 276-286.

Hamilton, W. J., Jr. 1943. The Mammals of Eastern United States. Comstock Publishing Company. Ithaca, New York.

Lovejoy, D. A. 1970. The Effect of Logging on Small Mammal Populations in the White Mountain National Forest of New Hampshire. Ph.D. Thesis. University of Connecticut.

Lull, H. W. 1968. A Forest Atlas of the Northeast. United States Forest Service. Northeastern Forest Experiment Station. Upper Darby, Pennsylvania.

Preble, N. A. 1956. Notes on the life history of *Napaeozapus*. Journal of Mammalogy 37: 197-200.

Snyder, L. L. 1924. Some details on the life history and behavior of *Napaeozapus insignis abietorum* (Preble). Journal of Mammalogy 5: 233-237.

United States Department of Commerce. 1968-1969. Climatological Data, New England, Annual Summaries, 1968-1969. Volumes 80-81.

Whitaker, J. O., Jr. 1962. *Endogone, Hymenogaster,* and *Melanogaster* as small mammal foods. American Midland Naturalist 67: 152-156.

Whitaker, J. O., Jr. 1963. Food, habitat, and parasites of the woodland jumping mouse in central New York. Journal of Mammalogy 44: 316-321.

Williams, O. and **B. A. Finney.** 1964. *Endogone*-food for mice. Journal of Mammalogy 45: 265-271.

Wrigley, R. E. 1969. Ecological notes of the mammals of southern Quebec. Canadian Field-Naturalist 83: 201-211.

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The Specialized Feeding Behavior of *Ambystoma gracile* in Marion Lake, British Columbia

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Henderson, B. A. 1973. The Specialized Feeding Behavior of *Ambystoma gracile* in Marion Lake, British Columbia. Canadian Field-Naturalist 87: 151-154.

Abstract. Analysis of the stomach contents of *Ambystoma gracile* feeding in the water column and on the mud revealed a marked difference in prey eaten in the two areas. The cladoceran, *Sida crystallina,* predominated among the water column feeders, whereas amphipods, chironomids, and molluscs predominated among the benthic feeders. Larval and second year *Ambystoma* learned different feeding behaviours as reflected in the different stomach contents.

Introduction

Most terrestrial and aquatic salamanders do not appear to exhibit any specialized feeding behavior (Anderson, 1960; Larson, 1965). The quality and quantity of food present in the stomach of most salamanders corresponds with the density and size of individuals of prey species in the habitat. There is evidence, however, that sympatric species of aquatic salamanders do have different strategies of hunting (Anderson, 1968). The present study describes the diet of *Ambystoma gracile* in Marion Lake, and reports experiments designed to determine if individuals can learn a foraging strategy.

Materials and Methods

During the period from 14 June to 28 August in 1969 and in the summer of 1968, *Ambystoma* were captured from Marion Lake. We sampled at night by rowing along the shallows and catching salamanders selected from both the sediment and the water column. The salamanders from the respective habitats were placed in separately labelled containers so that animals could be separated as to source. The stomachs were opened and the prey were separated by species.

Would *Ambystoma* which were exposed to one type of prey, i.e. benthic or water column prey, continue eating that prey when presented with a choice of benthic and water column prey? To answer this question, the following experiments were designed.

To three five gallon aquaria, I added surface sediment, containing benthic invertebrates, from the bottom of Marion Lake. Two other aquaria, of five and ten gallon capacity, held only a lilypad and *Sida crystallina.* Early in June of 1969, egg masses of *Ambystoma* were collected from the open mud, *Potamogeton* beds, and lily beds in Marion Lake. After hatching in large tubs, the larvae were transferred to the aquaria. Forty larvae were placed into each five gallon aquarium and 80 larvae into the ten gallon aquarium. I maintained the aquaria with sediment or *Sida* for one month; the aquaria were aerated throughout the experiment. After this month, I added sediment and *Sida* to all aquaria; I therefore presented all salamanders with a choice of alternate prey. Once in the first month and twice a week during the second month, I collected four larvae from each aquarium. A fine meshed net was dragged along the bottom of the aquaria so that all the salamanders were forced into the water column, then four salamanders were caught from the water column.

In a second experiment I lined two 2.5 x 1.3 x 0.6m plywood tanks with plastic mill roll. After leaching the tanks for a week with water from an adjacent creek, the tanks were filled with water to a depth of 0.5 meters. To one

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tank, I added Marion Lake surface sediment to a depth of 7 cm and into the other tank placed lilypads and *Sida*. The two tanks were constructed in the woods adjacent to the field station.

Fifty second-year larvae (4.5 cm from snout to vent) were collected from the traps in the lake and placed into each of the two tanks. The traps, polythene jugs with wire funnels fitted through the bases, were evenly distributed over the lake bottom so that the experimental animals were representative of the entire lake population. There was no evidence indicating that the traps were selective for either benthic or water column feeders.

Twice a week for a month, I placed either sediment or *Sida* into the respective tanks. After this month, both *Sida* and sediment were added to the tanks; the addition of *Sida* and sediment to each tank was continued for the following month. Each night during the first week following the addition of benthic and water column prey to each tank, five *Ambystoma* were removed from each tank. For the remaining three weeks I attempted to catch three salamanders once a week from each tank. The salamanders were preserved in alcohol until the experiment was completed and then the stomach contents were analyzed.

Results

In the sample collected from the lake in 1968 and 1969, *Ambystoma* found in the water column eat different food than do those caught on the mud (Table 1). Significantly more *Sida crystallina* are eaten by the salamanders found in the water column than salamanders found on the benthos; amphipods, chironomids, odonates, molluscs, and leeches predominate in the stomachs of *Ambystoma* feeding on the sediment.

In the first experiment, when larval *Ambystoma* were presented with a choice of benthic prey or *Sida,* the larvae reared on *Sida* ate more *Sida* than the salamanders reared on the benthic prey (Table 2). Analysis of variance ($F = 5.001$; $p < 0.05$) showed the difference was significant.

TABLE 1. — Prey taken by *Ambystoma* captured either in the water column or on the benthos are shown as the mean number of prey taken per centimeter of predator length ± S.E. The mean size of water column feeders was 4.3 ± 0.3 cm and that of benthic feeders was 3.4 ± 0.2 cm.

Prey	Water column feeders N = 32	Benthos feeders N = 70
Sida	56.159±9.069	0.527±0.215
Other Cladocera	0.027±0.027	0.427±0.234
Amphipods	0.893±0.264	1.756±0.263
Chironomids	0.404±0.107	0.543±0.106
Odonata	0.068±0.023	0.072±0.019
Pisidium	0.013±0.009	0.041±0.024
Leeches	0.016±0.011	0.060±0.021
Dipteran grubs	0.015±0.015	0.051±0.019
Caddis	0.014±0.010	0.007±0.007
Other	0.015±0.011	0.001±0.005

In the second experiment, second year larvae, 4.5 cm from snout to vent, which had been held in tanks containing either benthic or water column prey, continued to eat more of the prey to which they had previously been exposed when presented with a choice (Table 3). The means for number of *Sida* or amphipods eaten were significantly different by t tests ($p < 0.05$).

TABLE 3. — The mean number of each prey eaten per second year *Ambystoma* when they were presented with a choice

Prey	Water column feeders N = 38	Benthic feeders N = 32
Sida	102.7	58.1
Amphipods	6.8	13.6
Chironomids	2.2	2.9
Pisidium	2.5	3.1

Discussion

Both the larval and second year neotenic salamanders developed a specialized feeding behaviour as indicated by the analysis of the stomach contents. By increasing the encounter frequency with any one prey type in association with a particular habitat, the *Ambystoma*

TABLE 2. — Average number of prey per stomach in four larval *Ambystoma* presented with a choice of benthic and water column prey after being reared on either prey.

		Larvae reared on Benthic prey			Larvae reared on *Sida*	
Replica		1	2	3	4	5
	Sample					
	1	0.0	0.0	0.3	15.2	15.7
	2	17.3	9.3	13.0	45.6	30.1
	3	18.0	6.0	15.3	16.0	18.4
Sida	4	14.0	9.0	12.0		99.0
	5	14.5	16.6	12.3	20.8	29.0
	6	3.5	9.3	10.3	44.2	36.2
	7	13.3	12.0	13.8	48.3	57.3
	Mean	11.5	8.8	10.7	24.9	27.9
	1	0.0	0.7	0.7	1.0	1.0
	2	0.7	0.0	0.4	0.7	0.4
	3	0.0	0.4	0.0	0.5	0.0
Others	4	0.0	0.5	0.3	0.3	0.3
	5	0.3	1.0	1.7	0.0	2.6
	6	5.2	5.6	4.2	5.0	3.2
	7	0.5	1.0	0.0	0.3	1.8
	Mean	1.0	1.0	1.0	1.1	1.3

learned to respond selectively to a prey in a particular habitat. Although the training period was extensive, perhaps a shorter period may have the same effects. For this learned specialization to be advantageous for the salamander, the development of this "search image" (Tinbergen, 1960) must occur rapidly and in addition the search image must be abandoned for a prey species whose "profitability" (Royama 1970) has decreased below some threshold.

Among the Marion Lake salamanders, both generalized and specialized feeders can be found (a generalized feeder takes both benthic and water column prey whereas specialized feeders take either benthic or water column prey). The mechanism which explains the presence of generalized and specialized feeders in one lake is unknown but I suggest that interaction between individuals results in segregation of certain individuals into different habitats where the encounter frequency for a particular prey species is high. The individuals in the water column were significantly larger than the benthic feeders so perhaps these larger individuals possessed some physical attribute which facilitated foraging in the water column.

Iain Neish (personal communication) has observed the same individual *Ambystoma* foraging either in the water column or on the benthos in successive days. Individual search strategies are possibly maintained over an extended period if prey densities do not decrease within any one habitat so that the profitability of the prey is insufficient to maintain an individual salamander.

Although I have experimentally demonstrated that the *Ambystoma* are capable of prey selection, genetic differences between the two main specialized feeders cannot be dismissed.

Literature Cited

Anderson, J. D. 1968. A comparison of the Food Habits of *Ambystoma sigillatum*, A. *macrodactyleum croceum*, and A. *tigrinum californiense*. Herpetologica 24: 273-284.

Anderson, P. K. 1960. Ecology and evolution in island populations of salamanders in the San Francisco Bay Region. Ecological Monographs 30: 359-385.

Larson, D. W. 1965. The occurrence of neotenic salamanders *Ambystoma tigrinum diaboli* Dunn, in Devils Lake, North Dakota. Copeia 4: 309.

Royama, T. 1970. Factors governing the hunting behavior and selection of food by the great tit (*Parus major* L.). Journal of Animal Ecology 39: 619-668.

Tinbergen, L. 1960. The dynamics of insect and bird populations in pine woods. Archives Neerlanraises de Zoologie Tome XIII: 259-473.

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Effect of Herbicide-Induced Changes in Vegetation on Nesting Ducks

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Abstract. The effect of changes in characteristics of vegetation, induced by the herbicide, 2,4-D ester, on numbers and distribution of duck nests located on two islands in a lake in Alberta was studied over a 3-year period. Application of the herbicide significantly reduced the areas dominated by broad-leaved plants and permitted the expansion of areas dominated by grasses. Ducks preferred to nest among broad-leaved plants but avoided nesting among grasses. The distribution of duck nests was aggregated with concentrations of nests in areas of preferred cover which had remained unsprayed. Numbers of nesting ducks declined over the period of study. The implications of chages in vegetation in this decline are discussed.

Introduction

Species composition, physiognomy, and patterns of distribution are believed to be the most important characteristics of vegetation that influence the numbers of ducks using it for nesting purposes (Williams and Marshall 1938; Keith 1961; Swanson and Jeffrey 1965; Bengtson 1970). These three attributes are each subject to change under herbicide treatment (Egler 1968). The increasing use of chemical manipulation of vegetation on public and private land on the Canadian prairies (Daciw 1971), including areas heavily used by nesting ducks, raises the question of what indirect effect this practice is having on duck populations. From 1965 to 1967, we examined the effect of changes in the characteristics of vegetation, induced by herbicides, on numbers and distribution of ducks nesting on two islands in Miquelon Lake (53°16′ N, 112°55′ W), Alberta.

The Study Area

Two islands (A and C) were used in this study (Figure 1). They provided about seven and five acres, respectively, of vegetated habitat. Vegetation on the central portions of the islands was influenced considerably by colonies of California Gulls *(Larus californicus)* and Ring-billed Gulls *(L. delawarensis)*. These gulls tended to maintain the surface of large blocks of each island in a disturbed and heavily fertilized state that produced luxuriant stands of Canada thistle *(Cirsium arvense)*, sow thistle *(Sonchus arvensis)*, grey tansy mustard *(Descurainia richardsonii)*, *Axyris amaranthoides*, and nettle *(Urtica gracilis)*. Around the edge of each island was a band of vegetation dominated by grasses *(Hordeum jubatum* and *Glyceria striata)*. Bulrushes (*Scirpus* spp.) grew in low-lying portions of the islands, and a few small aspen *(Populus tremuloides)* and shrubs *(Ribes oxyacanthoides, Rosa woodsii,* and *Salix* sp.) grew on the highest and rockiest portions of the islands. Six species of ducks nested regularly on the islands. In order of decreasing abundance these were: Lesser Scaup *(Aythya affinis)*, Gadwall *(Anas strepera)*, White-winged Scoter *(Melanitta deglandi)*, Mallard *(A. platyrhynchos)*, Pintail *(A. acuta)*, and American Widgeon *(Mareca americana)*.

Methods

Observations were made from May to August in each of the three seasons (1965 to 1967).

We found waterfowl nests by systematic searching of each island two or three times weekly. Position of each nest and species of duck involved were recorded.

We analyzed vegetation by determining canopy coverage (Daubenmire 1959) of eight genera of plants *(Hordeum, Glyceria, Scirpus, Cirsium, Urtica, Sonchus, Carex,* and *Arteme-*

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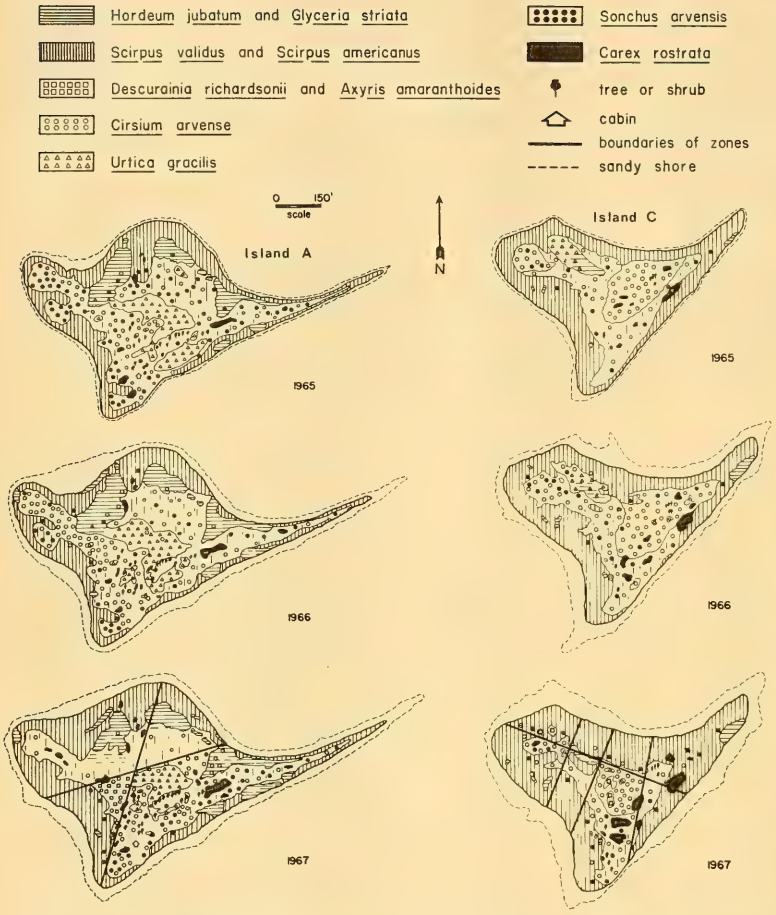

FIGURE 1. Islands A and C showing areas dominated by different plant species for the year 1965 through 1967.

sia) plus a miscellaneous group (mainly forbs) into which all others were lumped. Analyses were done along a series of permanent transects laid out on both islands (Figure 2). Twenty-five samples were taken at evenly spaced intervals adjacent to each transect. At Transect 5 on Island A and on Transect 4 on Island C samples were taken on either side of the line as these transects divided treated from control zones. Analyses were completed monthly from May to August 1966 and 1967. The analysis in May evaluated only dead vegetation more than 6 inches high, and subsequent analyses evaluated only new growth more than 3 inches high. In mid-July 1966, those parts of Island A west of Transect 5 (Zones 1 and 2) and those parts of Island C north of Transect 4 (Zones 2 and 3) were sprayed completely with the herbicide 2,4-D ester (2,4-dichlorophenoxyacetic acid) applied from a back-pack sprayer at the rate of 2 pounds per acre. In 1967 Zones 2 and 3 of Island A, and Zones 3 and 4 of Island C were sprayed regularly with the same equipment and herbicide and at the same rate about once a week from early June to mid-August.

Results

Nesting Waterfowl

The number of ducks recorded nesting on the two islands in Miquelon Lake for the years 1964 to 1967 is summarized in Table 1. The

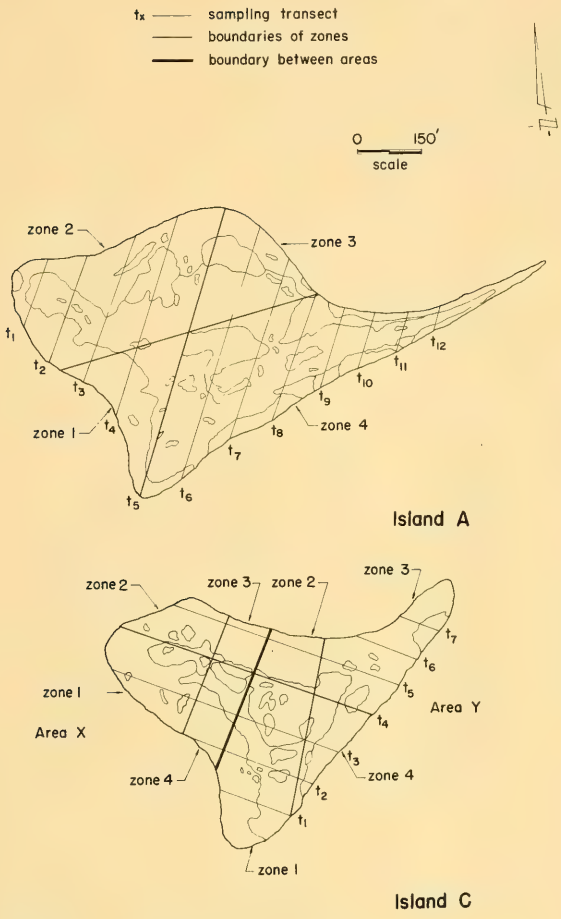

FIGURE 2. Islands A and C showing sampling transects and boundaries of zones superimposed on the distribution of plant communities present in 1967.

densities recorded are high compared to mainland situations (Martz 1967), but are typical of island situations, which seem to attract most species of nesting ducks (Hilden 1964; Anderson 1965; Townsend 1966; Bengtson 1970). In all years, the most common species was the Lesser Scaup with Gadwall second in abundance. Mallards, Pintails, scoters, and widgeons nested at considerably lower densities.

Between 1964 and 1967, the number of ducks nesting on the islands declined, largely as the result of a decline in the numbers of Lesser Scaup and Gadwall.

Characteristics of Vegetation

Amounts of residual vegetative cover used in May by nesting ducks on the two islands in Miquelon Lake are shown in Figure 3. More dry stems of thistles, bulrushes, and nettles but less dry stems of grass were present on Island A than on Island C. Herbicide, applied to parts of both islands in July 1966, prevented flowering of broad-leaved plants in that season. The effect on the amount of residual plant material present in the spring of 1967, however, was marked. None of the nettle stems remained standing on the sprayed zones, and the residual cover of thistle was reduced by 92% relative to the unsprayed zones.

The phenology of plant growth, as reflected in coverage characteristics, was determined by analyzing vegetation in mid-June, early and late July, and mid-August. In general the cov-

TABLE 1. — The number of duck nests, in which the clutch was completed and incubation begun, recorded on Islands A and C in Miquelon Lake, Alberta.

Species	Number of Nests				Density (nests/10 acres)			
	1964[a]	1965	1966	1967	1964[a]	1965	1966	1967
Lesser Scaup	67	70	41	24	55	58	33	18
Gadwall	29	25	18	17	24	20	14	12
White-winged Scoter	11	8	7	7	9	7	6	5
Mallard	12	6	5	7	10	5	4	5
Pintail	6	7	3	8	6	6	2	6
American Widgeon	5	2	2	1	4	2	2	1
Total	130	118	76	64	108	98	61	47

[a]From Vermeer 1967.

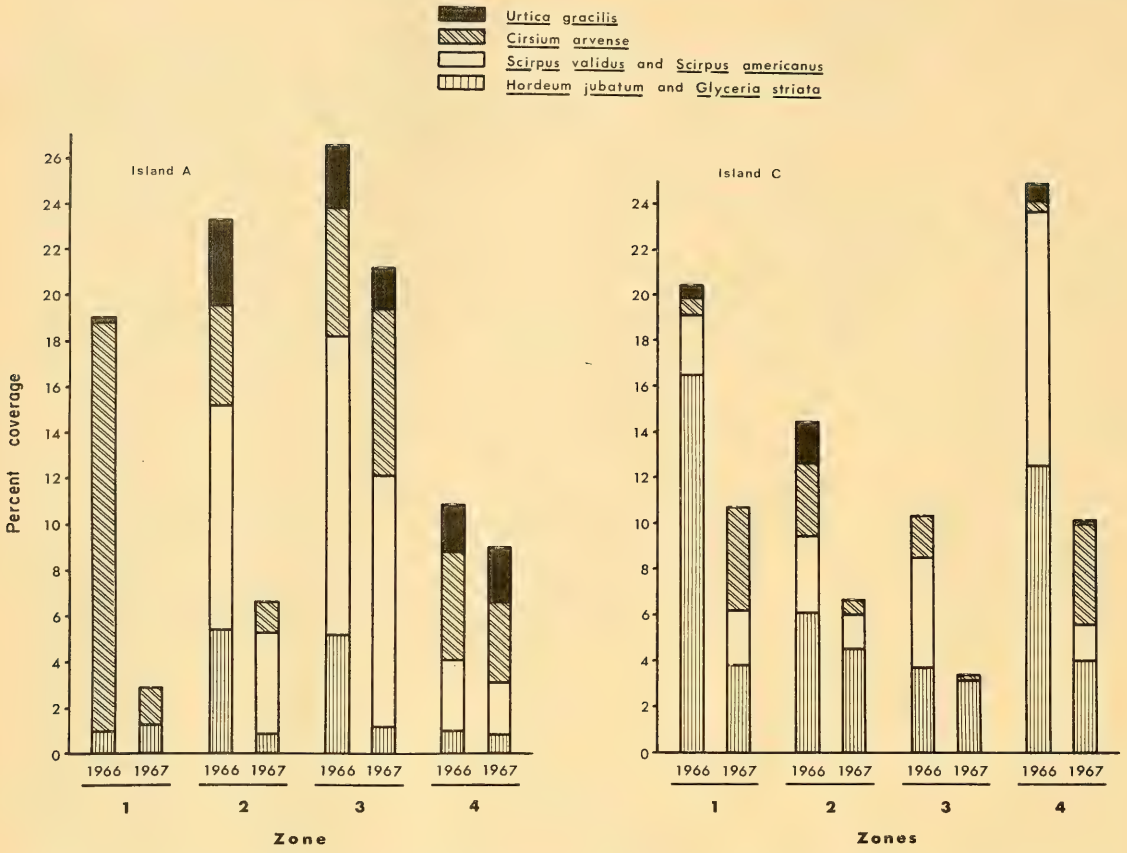

FIGURE 3. Percentage coverage of residual vegetation on islands A and C, May 25, 1966 and 1967. Zones 1 and 2 on Island A and Zones 2 and 3 on Island C were sprayed during July 1966.

erage of each species increased throughout the summer. Application of herbicide in mid-July of 1966 reduced the coverage of broad-leaved forms by 85%, relative to the untreated zones, in August 1966 (Figure 4). Nettles were effectively eliminated; grasses increased by 219% on the same areas 1 year after treatment.

Weekly application of 2,4-D ester throughout the summer of 1967 reduced the coverage of nettles and thistles in August from an average of about 30% to about 3% 1 year later (Figure 5). By contrast, the coverage of grasses in August increased from an average of about 11% to about 27%. The overall effect was to decrease plant coverage in 1967.

The effect on nettles and thistles of herbicide application in mid-July 1966 and weekly throughout June, July, and August of 1967, was much more dramatic (Figure 6). The single treatment in 1966 reduced the coverage of these genera by August, and the multiple treatment in 1967 virtually eliminated them. Again, the coverage of grasses increased remarkably from an average of about 10% in August 1966 to about 41% in August 1967. Thus, all treatments with 2,4-D ester reduced the coverage of broad-leaved forms, virtually eliminating some such as nettles, but allowing grasses to expand their distribution and increase their coverage.

The impact of these changes in coverage of old and new growth of vegetation, on nesting waterfowl, would depend on the relative attractiveness of these various plants to the ducks.

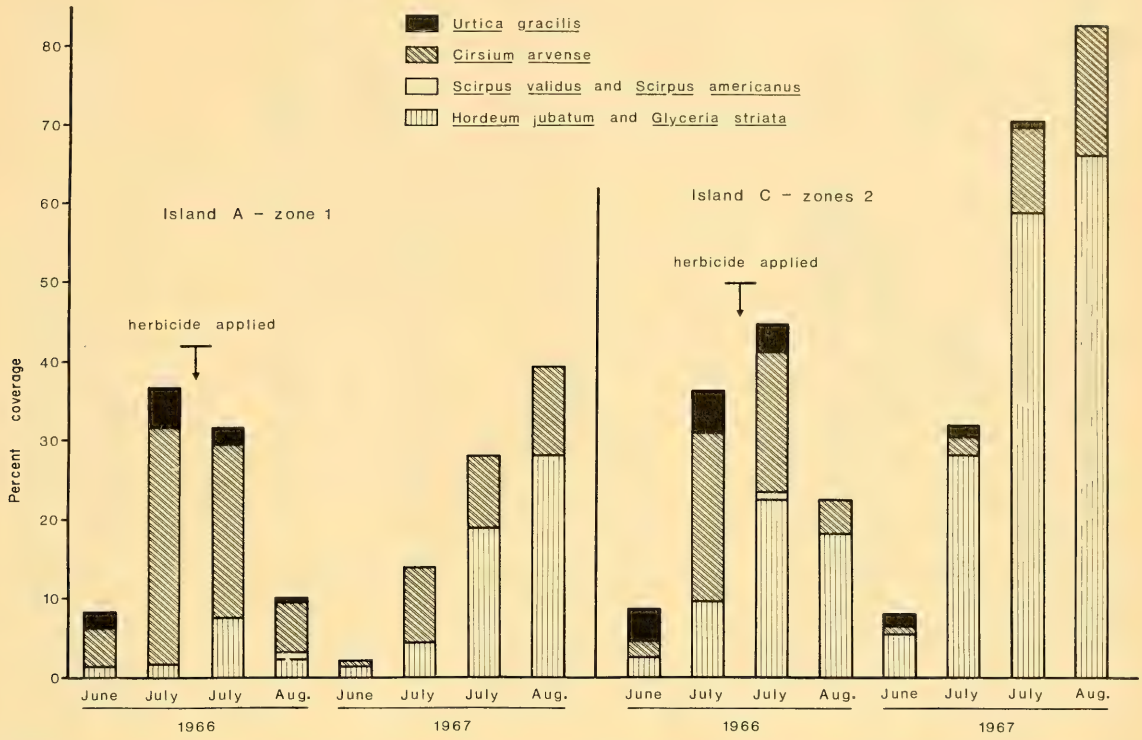

FIGURE 4. Phenological increase in vegetative cover in the zones on Islands A and C that were treated once with herbicide in 1966 but not in 1967.

Relationship between Nesting Waterfowl and Vegetation

Newly established duck nests were recorded over a period of 2 months, from early May to early July; consequently, they were associated with both old and new growth. Early-nesting species (Mallard, Pintail, and American Widgeon) usually nested among dead vegetation from the previous year, and late-nesting species (Lesser Scaup, Gadwall, and White-winged Scoter) nested mainly among new growth. Of all duck nests recorded on Islands A and C during three seasons of this study, between 28 and 30% were initiated in May. Mallard, Pintail, and American Widgeon were responsible for 80 to 100% of these early nesting attempts.

Before we could evaluate changes in the availability of the various types of residual cover, we had to determine the extent to which ducks exhibited preferences for the various types of vegetation. We did this by recording the number of nests associated with each of the dominant plants and compared these data with the availability of the respective plants, in terms of area dominated by them on each island (Table 2). Apart from differences in vegetation, both islands were relatively homogeneous in all other characteristics. Thus the difference between the percentage of the island under a dominant plant and the percentage of duck nests found therein was interpreted as evidence of preference or avoidance on the part of the waterfowl. Differences between utilization and availability of the various plants considered were significant for grasses, bulrushes, and miscellaneous plants. Residual growth of grasses and plants in the miscellaneous category were avoided by nesting Mallards, Pintails, and American Widgeons but residual growth of bulrushes attracted these three species. There is

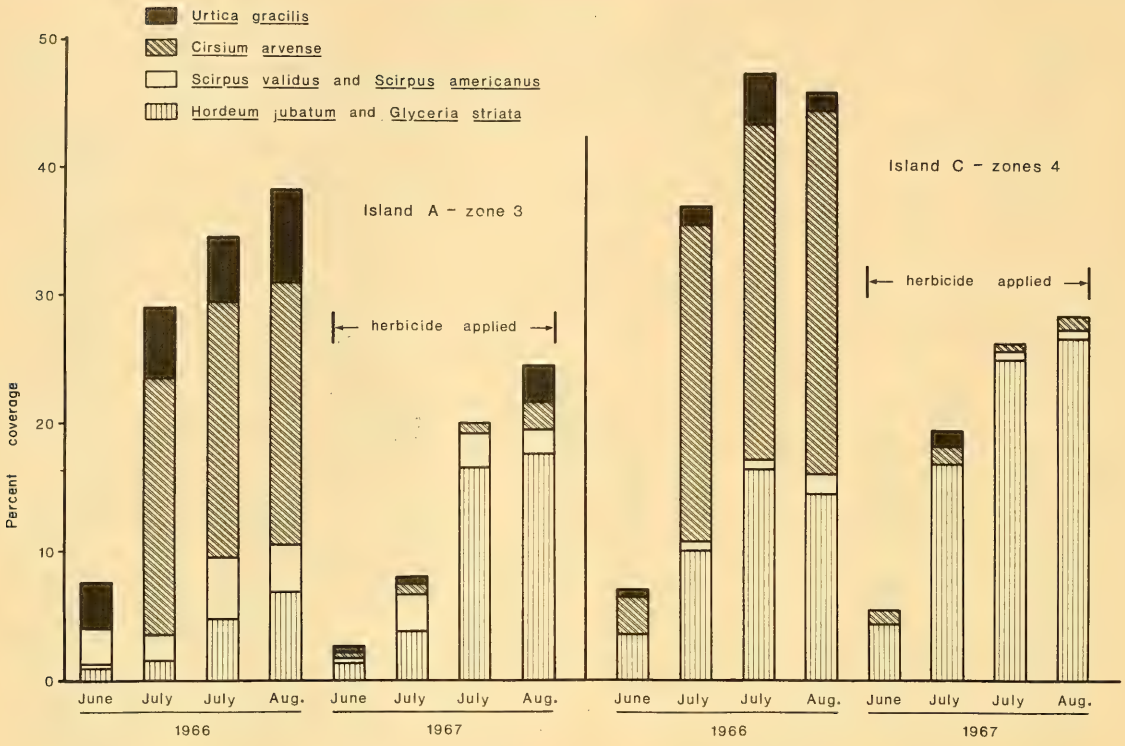

FIGURE 5. Phenological increase in vegetative cover in zones of Islands A and C that were not treated with herbicide in 1966 but were treated weekly from June to mid-August 1967.

also a suggestion that residual growth of thistles may have attracted early nesting ducks. Thus herbicide treatment favored the growth of grasses, which were avoided by nesting ducks, but inhibited the growth of perenial forbs, which may have attracted them.

The percentage of late nests located in new growth of various plants, and the percentage of the islands dominated by these plants are recorded in Table 3. Utilization and availability were significantly different for grasses, sedges, and nettles. Late-nesting ducks avoided grass-

TABLE 2. — Dominant plants associated with 18 Mallard, 18 Pintail, and 5 Widgeon nests and the availability of these plants based on the areas of Islands A and C where the plants were dominant.

Values	Percentage of nests in vegetation dominated by					
	Hordeum–Glyceria	*Scirpus*	*Carex*	*Urtica*	*Cirsium*	Others
Actual	7.3 (3)[a]	41.5(17)	4.9(2)	4.9(2)	31.7(13)	9.6(4)
Expected	43.1(18)[b]	10.5 (4)	1.8(1)	6.9(3)	20.7 (8)	17.2(9)
Probability[c]	< 0.005	< 0.005	> 0.5	> 0.25	< 0.10	< 0.05

[a]Parentheses enclose numbers of nests.
[b]Parentheses enclose numbers of nests expected if placement were unaffected by vegetation (percent of total area of islands under dominant plant(s) × total number of nests).
[c]Based on chi-square goodness-of-fit test with Yates correction.

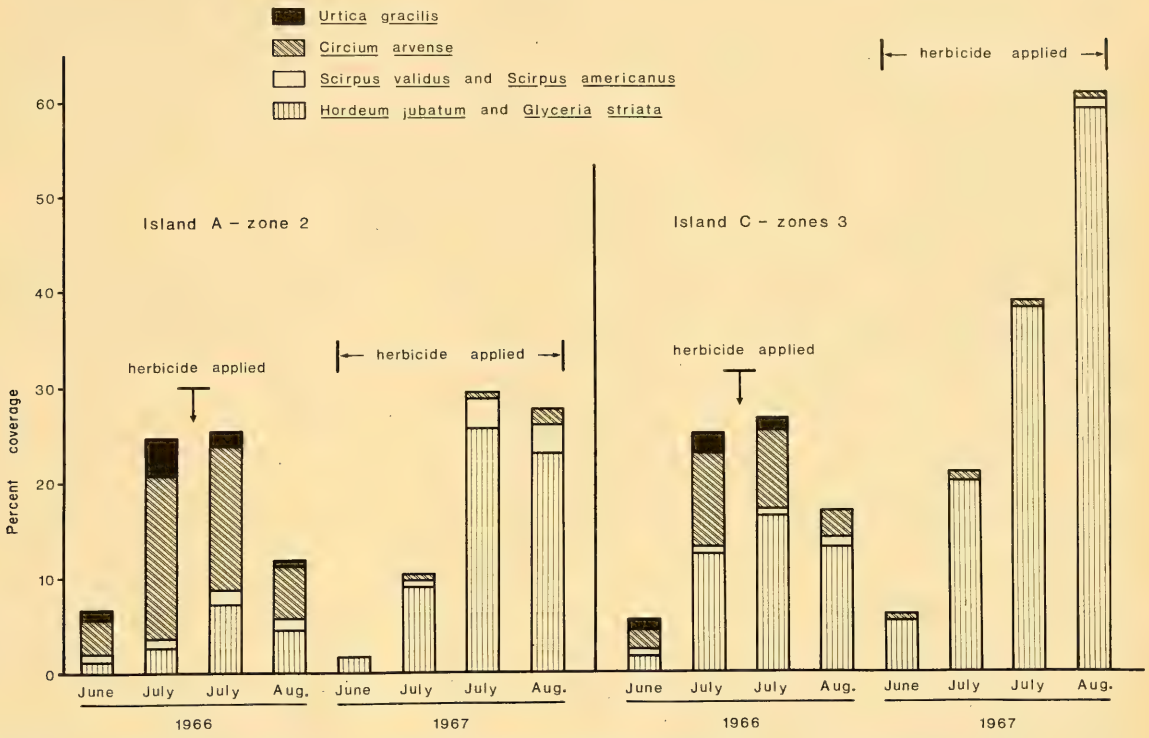

FIGURE 6. Phenological increase in vegetative cover in zones of Islands A and C that were treated with herbicide in both 1966 and 1967.

dominated areas but were attracted to areas dominated by sedges and nettles as nest sites. Lesser Scaup were particularly attracted to sedges; 19% of all scaup nests were located among these plants, which covered less than 2% of the land surface. Gadwalls were highly attracted to nettles; 58% of all gadwall nests were located among these plants, which covered less than 7% of the land surface. The attractiveness of nettles to nesting waterfowl, Gad-

TABLE 3. — Dominant plants associated with 135 Lesser Scaup, 60 Gadwall, and 22 White-winged Scoter nests and the availability of these plants, based on the areas of Islands A and C over which they were dominant.

Values	Percentage of nests in vegetation dominated by					
	Hordeum–Glyceria	*Scirpus*	*Carex*	*Urtica*	*Cirsium*	Others
Actual	11.1(24)[a]	9.7(21)	13.8(30)	31.8(69)	18.9(41)	14.7(32)
Expected	43.1(94)[b]	10.3(22)	1.8(4)	6.9(15)	20.7(50)	17.2(37)
Probability[c]	< 0.005	> 0.5	< 0.005	< 0.005	> 0.10	> 0.25

[a]Parentheses enclose numbers of nests.
[b]Parentheses enclose numbers of nests expected if placement were unaffected by vegetation (percent of total area of islands under dominant plant(s) × total number of nests).
[c]Based on chi-square goodness-of-fit test with Yates correction.

walls in particular, has been found in other studies (Miller and Collins 1954; Hammond and Mann 1956; Duebbert 1966).

Herbicide application induced changes in the availability of cover for nesting Lesser Scaup, Gadwall, and White-winged Scoter; these changes were most pronounced among the broad-leaved plants. The loss of nettles removed one of the species most favored by these ducks. The loss of thistles affected early-nesting species more than late-nesting species. The increase in coverage of grasses subsequent to herbicide treatment resulted in the reduction of a cover type in which the more preferred species of plants thrived. Coverage of sedges and bulrushes appeared to be more dependent on water levels than on competition with other species, hence the availability of new growth of these species fluctuated independently of effects of herbicides.

Distribution of Nesting Waterfowl

It is evident that ducks prefer to nest among certain plant species. Furthermore, availability of preferred species can be altered by 2,4-D ester. If preferences for specific plants are important in governing positions of nests, the distribution of nests should show an aggregated pattern in response to the heterogenous nature of the plant cover. To determine whether such a distribution was manifested, the position of each nest was recorded on both islands each year and the distances to nearest neighbors were measured after the method of Clark and Evans (1954) (Figure 7). All distributions varied significantly ($P < 0.01$) from randomness in the direction of aggregation. Thus for nesting ducks, at the densities encountered, vegetation seemed to be more important in governing their distribution than were forces such as inter- and intra-specific competition. There may be, however, an upper limit to the density that ducks tolerate, beyond which additional individuals may be forced to nest in adjacent, less preferred vegetation or to leave the area to nest.

If the preference was important and the upper level of density was not reached, the number of nesting waterfowl should have increased

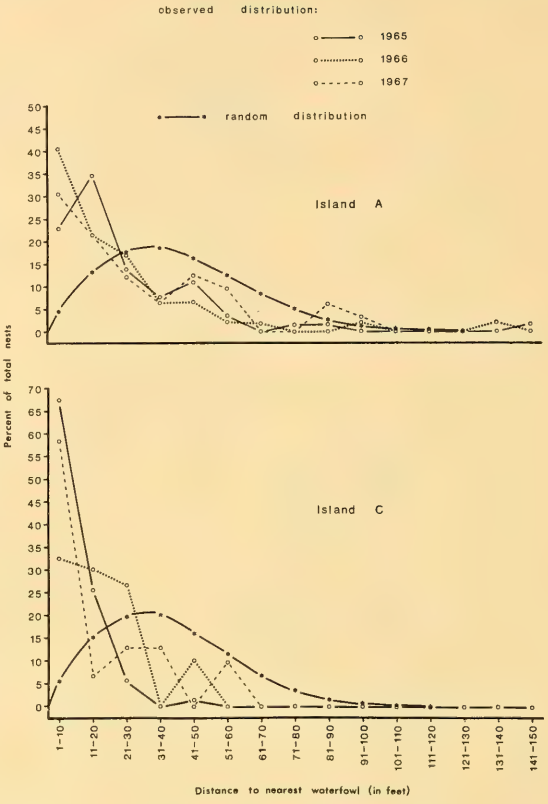

FIGURE 7. Distribution of distances between waterfowl nests on Islands A and C for the years 1965 through 1967.

in non-sprayed areas where preferred species existed and decreased in sprayed zones where preferred species were reduced or eliminated. Furthermore, if an upper limit in density was reached and preferred species were not available either the use of less attractive plants should increase or the population should decline.

We examined these possibilities by comparing the proportion of nests present in each zone on both islands for each year. The actual number of nests is listed in Table 4. In zones receiving no herbicide in 1966 the number of early and late nests declined between 1965 and 1966. However, the proportion of ducks nesting in these zones was not significantly different in the two years. In zones that remained untreated in 1967, the proportion of early nests showed a slight but non-significant increase.

TABLE 4. Number of duck nests in the various zones in Islands A and C in Miquelon Lake, Alberta.

Treatment	Yumber of duck nests							
	Early nests[a]			Late nests[b]			Total[c]	
	1965	1966	P^d	1965	1966	P^d	1965	1966
No herbicide Island A, zones 3 & 4; Island C, zones 1 & 4	10 1965–66[e]	3 1967	> 0.25	63 1965–66[e]	38 1967	> 0.5	118 1965–66[e]	77 1967
Island A, zone 4; Island C, zone 1	4	5	> 0.5	43	39	< 0.05	98	64
Herbicide mid-July 1966 Island A, zone 1; Island C, zone 2	2	1	> 0.5	12	1	< 0.05	98	64
Herbicide throughout 1967 Island A, zone 3; Island C, zone 4	2	7	< 0.05	7	1	> 0.10	98	64
Herbicide in July 1966 and throughout 1967 Island A, zone 2; Island C, zone 3	4	2	> 0.5	24	7	< 0.05	98	64

[a]Early-nesting species: Mallard, Pintail, and American Wideon.
[b]Late-nesting species: Lesser Scaup, Gadwall, and White-winged Scoter.
[c]Total number of nests on both islands.
[d]Fishers Exact Test used in all comparisons of proportions present in particular zones when any of the cells in the 2 × 2 table contained a sample of less than 5; otherwise chi-square tests with Yates correction were used.
[e]Mean number of nests on both islands for 2-year period.

However, the proportion of late nests in these zones increased significantly. This suggested that these zones possessed characteristics that were more attractive than zones in which the vegetation had been modified and in which a decline in usage should be evident.

In zones treated with herbicides once in mid-July 1966, coverage of thistles used by early-nesting ducks was reduced. However, there was no difference in the proportions of early nesting ducks using these zones in the two years but the proportion of late nests located in these zones in 1967 declined significantly. This was probably because Zone 2 on Island C was largely covered with grass, plants that benefited from the herbicide treatment in 1966 but which were avoided by nesting ducks. Two broad-leaved annuals *(Descurainia* and *Axyris)* grew on Island A in the space created after the elimination of thistles by 2,4-D ester in 1966. Both of these plants were avoided by nesting ducks.

In zones that received regular herbicide treatment throughout the summer months of 1967 but that had not been treated previously, the proportion of early nests rose significantly in 1967. This is not surprising as herbicide treatment in 1967 affected only new growth, not the vegetation produced in 1966 that was being used by these early-nesting ducks. Decline in the proportion of late nests located in these zones probably reflected the virtual elimination of broad-leaved plants.

In zones treated with herbicides in mid-July 1966 and throughout the summer of 1967, the

proportion of early nests decreased in 1967. The proportion of late nests located in these zones showed a significant decline, again probably because all broad-leaved plants were eliminated.

Discussion

The number of ducks nesting annually on the two islands under investigation declined over the 3-year period of study. Repeated human intrusion onto the islands was considered a possible reason for this decline. However, in view of the greatly increased numbers of ducks nesting on the same islands in 1968 (103) and 1969 (101) in the face of similar human disturbance (Long 1970), we discarded this possibility. Another possibility was that population trends on the islands were reflecting those of the area as a whole. We compared numbers of nesting waterfowl on islands in Miquelon Lake with those of the central part of the province (Alberta Division of Fish and Wildlife, unpublished data) and found no relationship. Thus, we concluded that changes in populations of ducks over the area as a whole could not explain the changes in numbers of nesting ducks in the study area. The remaining obvious possibility was that the decline in availability of plants preferred for nest sites, as the result of herbicide treatment, had prevented some ducks from nesting there. The data presented on distribution of nests leave little doubt that ducks showed preferences for nesting in association with specific plants, a conclusion similar to that of Bengtson (1970), who showed that nesting ducks preferred specific growth forms of plants. Furthermore, we found that elimination of such preferred plant species led to significant declines in the numbers of ducks nesting in the treated areas and increases in the adjacent untreated areas. Furthermore, the increase in numbers of nesting ducks recorded by Long (1970) on the same islands in 1968 and 1969, after cessation of herbicide treatment, was correlated with an increase of approximately 300% in size of area dominated by preferred plant species. Thus, changing the local species composition of vegetation caused a redistribution of nesting ducks, and probably a decrease in total numbers involved.

The impact of herbicide treatment of extensive tracts of vegetation and the elimination of broad-leaved plants among which ducks prefer to nest could be significant in the production of waterfowl over a broad area. This assumes that preferences exhibited by ducks for nesting in association with specific plants have evolved through natural selection and have survival value. Thus the elimination of preferred species, which would force ducks to nest in association with non-preferred species, could conceivably have a deleterious effect on waterfowl production.

Acknowledgments

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Literature Cited

Anderson, W. 1965. Waterfowl production in the vicinity of gull colonies. California Fish and Game 51(1): 5–16.

Bengtson, S.-A. 1970. Location of nest-sites of ducks in Lake Myvatn area, north-east Iceland. Oikos 21(2): 218–229.

Clark, P. J. and **F. C. Evans.** 1954. Distance to nearest neighbor as a measure of spatial relationships in populations. Ecology 35(4): 445–453.

Daubenmire, R. F. 1959. A canopy cover method of vegetation analysis. Northwest Science 33(1): 43–64.

Daciw, M. 1971. Herbicide used agriculturally in western Canada for weed control. Economics Branch, Manitoba Department of Agriculture. mimeo 2 pp.

Duebbert, H. F. 1966. Island nesting of the gadwall in North Dakota. Wilson Bulletin 78(1): 12–15.

Egler, F. E. 1968. Herbicides. *In* A practical guide to the study of the productivity of large herbivores. IBP Handbook No. 7. *Edited by* F. B. Golley and H. K. Buechner. Blackwell, Oxford. pp. 252–255.

Hammond, M. C. and **G. E. Mann.** 1956. Waterfowl nesting islands. Journal of Wildlife Management 20(4): 345–352.

Hilden, O. 1964. Ecology of duck populations in the island group of Valassaaret, Gulf of Bothnia. Annales Zoologica Fennici 1: 153–279.

Keith, L. B. 1961. A study of waterfowl ecology of small impoundments in Southeastern Alberta. Wildlife Monographs, No. 6. 88 pp.

Long, R. J. 1970. A study of nest-site selection by island-nesting anatids in central Alberta. M.Sc. thesis, University of Alberta. 123 pp.

Martz, G. F. 1967. Effects of nesting cover removal on breeding puddle ducks. Journal of Wildlife Management 31(2): 236–247.

Miller, A. W. and **B. D. Collins.** 1954. A nesting study of ducks and coots on Tule Lake and Lower Klamath National Wildlife Refuge. California Fish and Game 40(1): 17–59.

Swanson, C. V. and **R. G. Jeffrey.** 1965. Pintail duck breeding records in western Washington. Murrelet 46(1): 12–14.

Townsend, G. H. 1966. A study of waterfowl nesting on the Saskatchewan river delta. Canadian Field-Naturalist 80(2): 74–88.

Vermeer, K. 1967. A study of two species of gulls, *Larus californicus* and *L. delawarensis,* breeding in an inland habitat. Ph.D. thesis, University of Alberta. 128 pp.

Williams, C. S. and **W. H. Marshall.** 1938. Evaluation of nesting cover for waterfowl on Bear River Refuge. Transactions of North American Wildlife Conference 3: 640–646.

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Notes

Distribution of the Pocket Gophers *Geomys bursarius* and *Thomomys talpoides* in Manitoba

The northern pocket gopher *(Thomomys talpoides)* is a widespread species in the grasslands of southern Manitoba, while the plains pocket gopher (*Geomys bursarius*) is restricted in Manitoba to a small area east of the Red River and south of the Roseau River, its only range in Canada (Figure 1, inset). The present study attempts to define the distributions of the two species, particularly in the areas of possible overlap.

Bailey (1926, p. 126) first recorded the presence of *Geomys* at Emerson, and Soper (1944) collected 10 specimens 2.1 miles north of the Manitoba–Minnesota border and 11.5 miles ENE of Emerson. In 1971 and 1972 three field parties of the Manitoba Museum added 29 more specimens from 20 localities (Figure 1), extending the range 10 miles to the north (3 miles west of Roseau River) and 12 miles east (1 mile south of

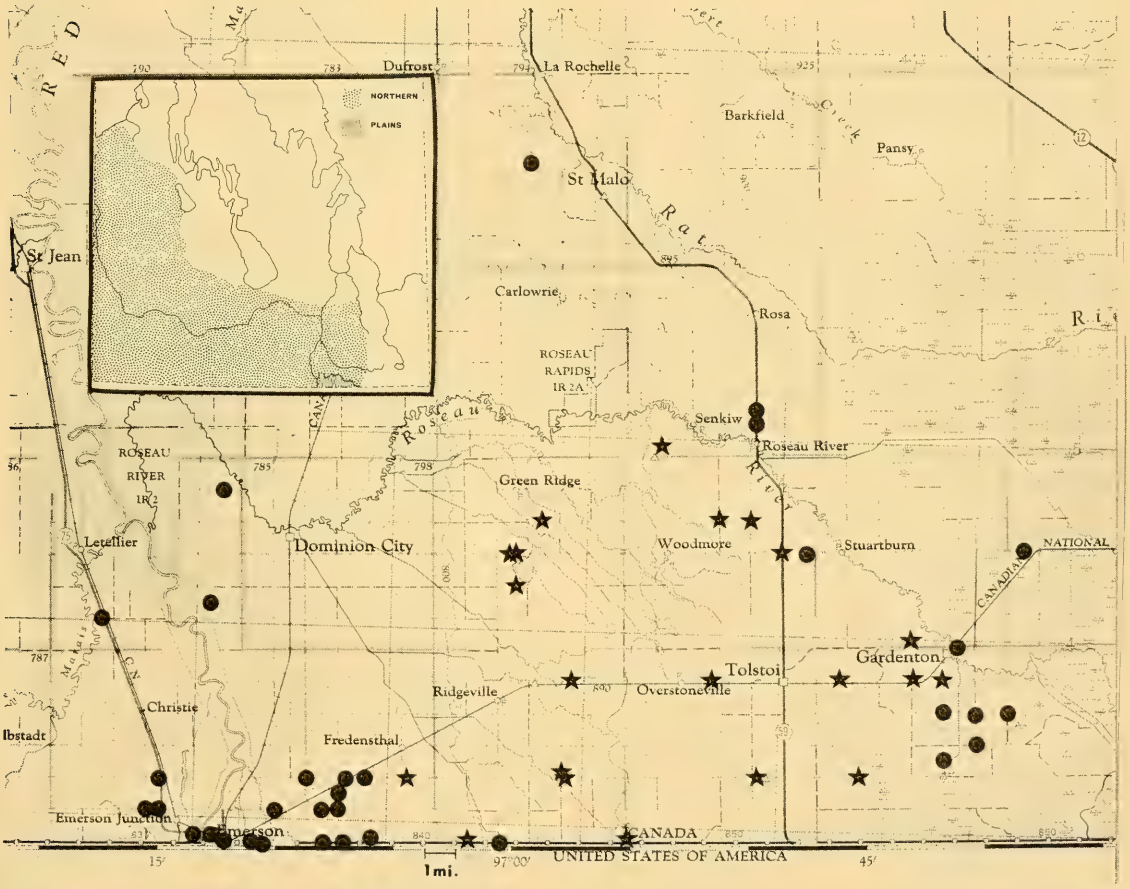

FIGURE 1. Present distribution records of the plains pocket gopher (stars) and northern pocket gopher (dots) in southeastern Manitoba. (Winnipeg sheet 62H, Surveys and Mapping Branch, Department of Energy, Mines, and Resources, Ottawa). Inset, general distributions of the northern and plains pocket gophers in Manitoba.

Gardenton). Soil type did not appear to be a major factor limiting the dispersal of this species, since individuals were found in sand and glacial till as well as rich loam. Wet or wooded habitats were avoided to a greater degree by *Geomys* than by *Thomomys*. Throughout its range *Geomys* is typically an inhabitant of tall-grass and mixed-grass prairie, and it was interesting to find the cheek pouches and underground storage chamber of one specimen from Gardenton filled with root-stocks of big bluestem (*Andropogon gerardii*), a characteristic grass species of these communities. The majority of both species of pocket gophers in this area was limited to the edges of fields, roadways, and railroad allowances, owing to extensive cultivation and the presence of aspen–oak forest and marsh in the east. *Geomys* was very abundant in certain fields, particularly those planted with alfalfa, and one farmer reported trapping at least 100 gophers along the edge of his property over several years. During spring flooding he noticed their movement (through the appearance of new mounds) from the saturated fields to the higher roadbanks.

As Soper (1944) remarked, the mounds of the plains and those of the northern pocket gophers are indistinguishable. The tunnels of *Geomys* are generally of greater diameter, which is understandable considering its larger body and claw size (Figure 2). *Thomomys* had not previously been found in this region east of the Red River, so we were greatly surprised when this species appeared in many traps where *Geomys* was expected. In the vicinity of Emerson, where *Geomys* had been reported over 50 years ago, *Thomomys* was now very abundant, even in lawns. Further specimens of *Thomomys* were taken west of Dominion City and Stuartburn, and south of Gardenton. The ranges of the two species are parapatric, within a mile of each other at five localities. In fact, the Manitoba population of *Geomys* is almost surrounded by *Thomomys* and the Roseau River.

Bailey (1926, p. 126) commented on the distributional pattern of the two species, "For a distance of more than 1000 miles, roughly from Pembina (North Dakota) to El Paso (Texas), the ranges of *Geomys* and *Thomomys* meet without any extensive overlapping, *Geomys* occupying generally the mellow soil of the fertile valley country and *Thomomys* the higher, drier, and often more sterile soils to the west". He believed that the larger, more aggressive *Geomys* forced *Thomomys* out of the more fertile regions. The parapatric distributions of these two species in Manitoba are therefore a continuation of a widespread pattern. A comparison of their total ranges in North America (Hall and Kelson 1959, Maps 268 and 272) suggests that, after the retreat of the Wisconsin glaciers, *Thomomys* invaded Manitoba from the southwest, while *Geomys* moved in from the southeast. We speculate that since *Thomomys* is a more northerly adapted species, it probably arrived in the Roseau River area first, and was later partially excluded by an invasion of the more competitive *Geomys*. The replacement of *Geomys*

FIGURE 2. The northern pocket gopher (upper) and plains pocket gopher (lower). Note the larger size, grooved upper incisors and proportionately larger claws of the plains species.

by *Thomomys* at Emerson over the last 50 years, and other possible minor alterations in their ranges, may have been influenced by man's activities and by local flooding. West of the Red River, *Geomys* approaches the Manitoba border from eastern North Dakota. Perhaps the northwestern dispersal of this species has been slowed by the abundance of *Thomomys* in the area.

The range of *Thomomys* has been extended farther east than reported by Criddle (1930, p. 266) and Soper (1961, p. 191) with our recent records from the following localities: Birds Hill Park; 2.5 miles south, 3 miles east of Beausejour; 1 mile east of Anola; 5 miles east of Richer; 5 miles east of Marchand; Sandilands; Caliento. These records form the easternmost limits known for the species. Further east are areas of unsuitable habitat — jack pine forest on well-drained Agassiz beach ridges, white spruce – aspen forest on mesic sites of glacial till, and black spruce – tamarack forest or sedge-willow shrub in wet, low-lying areas.

Gene frequencies in peripheral populations of pocket gophers are often different from those in populations from the central part of the range Mayr 1963, pp. 386–393). Such is the case in the northwesternmost population of *Thomomys* in Manitoba, near Swan River. Soper (1961) reported one melanistic specimen from here, and three of four specimens we collected several miles south of the town were also black. Another peripheral individual from Dauphin Lake was black with a brownish cast. The only other abnormally colored *Thomomys* out of 150 specimens we examined from Manitoba were an albino from Pratt (12 miles south, 25 miles west of Portage la Prairie) and a partial albino from Treesbank.

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Literature Cited

Bailey, V. 1926. A biological survey of North Dakota. North American Fauna 49: 1–226.

Criddle, S. 1930. The prairie pocket gopher, *Thomomys talpoides rufescens*. Journal of Mammalogy 11: 265–280.

Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America. Vol. 1. Ronald Press, New York. pp.1–546.

Mayr, E. 1963. Animal species and evolution. Harvard University Press, Cambridge, 797 pp.

Soper, J. D. 1944. The Mississippi Valley pocket gopher (*Geomys bursarius* Shaw) in Manitoba. Canadian Field-Naturalist 58: 71–72.

Soper, J. D. 1961. The mammals of Manitoba. Canadian Field-Naturalist 75: 171–219.

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Observation of Greater Scaup at Ellice River, Northwest Territories

During 4–18 June 1971, I was assisting with a caribou, *Rangifer tarandus,* calving survey conducted by the Northwest Territories Game Management Branch and the Canadian Wildlife Service in the vicinity of the Ellice River (67°27′ N, 140°42′ W) about 100 miles northeast of Bathurst Inlet, Northwest Territories. On 16 June, I observed a pair of Greater Scaup, *Aythya marila,* on a small tundra pond (50 × 80 m) interspersed with several small grass tussocks 2–3 m in diameter. The ducks were quite tame and appeared to be occupying a breeding territory but no nest was found.

This observation is approximately 300 miles beyond the known breeding range of the Greater Scaup (Godfrey. 1966. The birds of Canada. National Museum of Canada Bulletin 203. p. 68). in the District of Mackenzie. However, Snyder (1957. Arctic birds of Canada. University of Toronto Press. p. 284) noted the observation of Greater Scaup (no date) at Bathurst Inlet by the Canadian Wildlife Service. At present the breeding distribution of this species is poorly understood owing to limited ornithological reconnaissance in the central Arctic.

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A Second Probable Hybrid of *Larus marinus* and *L. argentatus* on the Niagara River

On 21 November 1971 Arthur R. Clark sighted a dark-mantled adult gull standing among Herring Gulls on a concrete retaining wall at the southern end of the newer Sir Adam Beck Generating Station about 3 km upstream from Queenston, Ontario, Canada. It was also seen that day by several other birders and later was found standing among a flock of Herring Gulls on a level gravel area across the river in the United States at the downstream end of the Niagara Power Project station. We collected the bird in this place on 22 November. Based on its intermediate characters between the supposed parents and its dissimilarity to any known gull species we believe that it is a hybrid between the Great Black-backed Gull (*Larus marinus*) and the Herring Gull (*L. argentatus*). This individual is similar to a female gull (BSNS 6437) that we secured on 5 December 1970 in the same area (Andrle 1972) and it resembles also another female specimen taken on Staten Island, New York, in 1959 by Jehl (1960). Both of these are considered hybrids between *L. marinus* and *L. argentatus*.

The second Niagara specimen is an adult female (BSNS 6503) in winter plumage, slightly fat, with ovary 20 × 8 mm and weight 1355.8 g. Head, neck, underparts, and tail are white; the crown, nape, sides of head and neck and upper breast have heavy, dark-brown streaks which become finer on the sides of the head and neck and upper breast than those of the 1970 bird. The mantle is very slightly darker gray than that of the first Niagara specimen. It most closely corresponds to the Neutral Gray of Ridgway (1912). The 10th (outermost) primaries are not fully grown. That on the right wing (the one on the left wing was lost) has a 46-mm-long subterminal pale gray and white spot extending completely across both vanes, and the ninth primaries have 19- and 15-mm-long subterminal spots on the left and right wings, respectively, extending across both vanes but not reaching the edges. Bill is whitish-yellow tinged greenish, the terminal one-third brighter yellow with a yellow spot, tinged orange, on the lower mandible at the gonys. There are irregular black marks on both sides of the terminal half of the lower mandible and a V-shaped blackish mark on the terminal half of the upper mandible with its apex directed proximally on the culmen. Irides are pale olive-yellow finely flecked with brown. The eye-ring is pale whitish-yellow and the legs and feet are whitish tinged flesh.

Measurements (mm) of the second Niagara gull are: wing (not measurable because of short 10th primaries); tail, 169; tarsus, 68; exposed culmen, 49.9; bill (depth at base), 19.8; bill (depth at gonys), 20.8. This bird generally measures somewhat smaller than the other two presumed hybrids. All three specimens have bill depths at base and gonys exceeding the maxima Dwight (1925) gives for 16 female specimens of *L. a. smithsonianus*.

I brought out in a discussion of the 1970 specimen (Andrle 1972) that it differed in one or more characters, including mantle color, from other similar Northern Hemisphere dark-mantled gull species. The 1971 bird does so as well. I also mentioned the variability in gulls' primary patterns, winter head streakings, and eye-ring and leg coloration, and that these characters in the three presumed hybrids probably cannot be used to reach any definite conclusions as to their relationships. Hybrid offspring of *L. marinus* and *L. argentatus* have been produced in captivity, but the absence in the literature with which I am familiar of a complete description of an adult hybrid from these cases precludes comparison. No instance of an interspecific cross involving these species under natural conditions is known to me.

The securing of four presumed hybrids of *L. marinus* and *L. argentatus* in a period of 13 years, including one from Kingston, Ontario, described in an accompanying note, may be indicative of an increased incidence of hybridization between these two sympatric species, which are apparently increasing in numbers and expanding their ranges. Possibly supporting the likelihood of increased hybridization is the fact that yearly field observations of gulls in the Niagara Frontier Region by many experienced birders during about four decades prior to the sighting of single suspect individuals in 1968 and 1969, and the collection of these two specimens here, have not, so far as I know, produced either a possible sight record or a specimen of such a hybrid.

For permission to operate on Ontario Hydro and Niagara Power Project properties, I thank Hugh MacDonald, Plant Superintendent of the Sir Adam Beck Station, William H. Latham, former Resident Manager of the Niagara Station,

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Literature Cited

Andrle, R. F. 1972. Another probable hybrid of *Larus marinus* and *L. argentatus*. Auk 89: 669–671.

Dwight, J. 1925. The gulls of the world; their plumages, moults, variations, relationships and distribution. Bulletin of the American Museum of Natural History, Vol. LII: 182.

Jehl, J. R., Jr. 1960. A probable hybrid of *Larus argentatus* and *L. marinus*. Auk 77: 343–345.

Ridgway, R. 1912. Color standards and color nomenclature. Published by the author. Washington, D.C.

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More Presumed Hybrid Gulls: *Larus argentatus* × *L. marinus*

Specimens of presumed hybrids between the Herring Gull (*Larus argentatus*) and the Great Black-backed Gull (*L. marinus*) have been recorded by Jehl (1960) and Andrle (1972). A third similar specimen is described by Andrle in this issue of *The Canadian Field-Naturalist*.

There is a fourth such gull specimen in the National Museum of Natural Sciences. It is No. 54183, a large, darkish-mantled adult female from Kingston, Ontario, January 12, 1967, which was carefully observed in a large gathering of Herring Gulls by Dr. Eric L. Mills, Dr. Fred Cooke, and others.

In this specimen, the head and neck are white. The occiput, nape, and hind neck are very lightly streaked with dusky (heaviest on hind neck). Mantle is close to Neutral Gray of Ridgway (1912), averaging perceptibly darker than that of the California Gull (*L. californicus*). Tenth (outermost) primary with a subterminal white spot extending across both webs, 46 mm long on left wing, 47.5 on right wing, respectively; ninth primary with a 21-mm white spot completely across inner web and extending onto outer web. Tail and under parts white. Bill straw yellow with greenish cast, and with an orange yellow spot at the gonys. Irides straw yellow with a few gray flecks. Orbital ring yellow. Legs grayish flesh with greenish cast; toes pinkish. Its measurements (in mm) are as follows: wing, 446; tail, 174; tarsus, 74; exposed culmen 55.7; bill depth at base, 19.9; bill depth at gonys, 20.4.

The four known specimens in museums are rather uniform. All are females. In size they are intermediate between *L.a. smithsonianus* and *L. marinus*, but with a relatively deep bill and well developed tarsus (Table 1). In color also they are intermediate, but nearer *L.a. smithsonianus*, with a Neutral Gray mantle and a yellow orbital ring. Two of the skins (and an additional living bird described below) are lightly streaked on head and neck as in *L. marinus*.

There is a sight record of a fifth individual. It was carefully observed by Roger A. Foxall at Nepean Bay, Ottawa, Ontario, on November 23, 1972, and was seen also by Ronald Pittaway on November 25 and 28. The writer is grateful to Dr. Foxall for the use of his field notes concerning observations of the following details. The gull was observed through a zoom 20× to 45× telescope as it flew, swam, bathed, and perched at distances as close as 100 feet. Possibly significant is the fact that it sat close to a single adult Great Black-backed Gull in a company of some 25 Herring Gulls, mostly adults. By direct comparison, its size and mantle coloration were determined as intermediate between those of the Herring and Great Black-backed gulls. The two outermost primaries had 'white mirrors' near their tips. Head almost pure white with slight streaking, and this restricted to the back of the head (thus similar to that of the Great Black-backed Gull nearby). Bill yellow with red spot on lower mandible; depth of bill at angle greater than in the Herring Gulls present. Iris pale yellow. Orbital ring appeared pale and yellowish. Legs dark pink (slightly darker than those of Herring Gulls present).

TABLE 1. — Measurements (mm) of female *L. marinus* and *L. a. smithsonianus* compared with those of four presumed hybrids.

	*L. marinus**	4 presumed hybrids	*L. argentatus smithsonianus**
Wing (chord)	454–491 (465.8)	433–446 (438)	397–422 (410.6)
Tail	181–209 (189.4)	169–175 (172.5)	154–178 (165.3)
Tarsus	74–81 (75.7)	68–74 (70.5)	57–66 (62.1)
Exposed culmen	57–66 (60.7)	49.9–57 (53.5)	47–53 (50.1)
Bill (depth at base)	21–24 (22.3)	19.8–22 (20.5)	16–18 (17.0)
Bill (depth at gonys)	22–27 (24.0)	20.4–21.5 (21.1)	17–20 (18.0)

*From Dwight (1925).

What are these puzzling gulls? They certainly are not referable to any single North American taxon. Of the Eurasian gulls they superficially resemble *L. schistisagus* but differ in possessing a decidedly paler mantle and a yellow, instead of a vermilion, orbital ring, as well as in some details of the markings of the primaries. Phenotypically they most closely resemble certain Siberian subspecies of *L. argentatus,* but differ consistently from the large very dark-mantled subspecies *heuglini* in the coloration of the orbital ring and tarsus. They resemble even more closely *L.a. vegae* of northeastern Siberia, but have a darker mantle, average larger size (especially depth of bill), and the orbital ring is consistently yellow instead of vermilion. Although *L.a. vegae* is of casual occurrence on the northwestern coast of North America (western Alaska and British Columbia) it seems highly unlikely that this subspecies has suddenly started turning up almost regularly in eastern North America.

In eastern Canada and northeastern United States the Herring and Great Black-backed gulls have increased greatly in numbers in recent years with the latter wintering in ever-increasing numbers in the eastern interior. Within the past 20 years a few Great Black-backed Gulls have remained in the interior and nested in such Ontario localities as Little Haystack Island, Lake Huron (Krug 1956); Presqu'ile Park (Baillie 1963); and Kingston (Edwards 1972).

The first known appearances of these presumed hybrids are very recent and coincide with the increase and nesting of the Great Black-backed Gull in the interior. It seems reasonable to suppose that some individuals of that species remaining in the interior during the nesting season would be unable to find mates of their own species. Such circumstances would seem favorable for a certain amount of hybridization with the much commoner Herring Gull. It would appear, therefore, that these puzzling gulls originate under such conditions by hybridization between *L.a. smithsonianus* and *marinus,* mainly in the eastern interior.

Literature Cited

Andrle, R. F. 1972. Another probable hybrid of *Larus marinus* and *L. argentatus.* Auk 89(3): 669–671.

Baillie, J. L. 1963. The 13 most recent Ontario nesting birds. Ontario Field Biologist 17: 22.

Dwight, J. 1925. The gulls (Laridae) of the world; their plumages, moults, variations, relationships and distribution. Bulletin of the American Museum of Natural History 52, Article 3: 63–336.

Edwards, M. H. 1972. 1971 and 1972 Pigeon Island breeding bird censuses. Blue Bill 19(3): 37–38.

Jehl, J. R. 1960. A probable hybrid of *Larus argentatus* and *L. marinus.* Auk 77(3): 343–345.

Krug, H. H. 1956. Great Black-backed Gulls nesting on Little Haystack Island, Lake Huron. Auk 73(4): 559.

Ridgway, R. 1912. Color standards and color nomenclature. Published by the author. Washington, D.C. pp. 1-43.

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Endemism and Conservation of Sticklebacks in the Queen Charlotte Islands

The Queen Charlotte Islands, located off the coast of northern British Columbia, have long been noted for their endemic biota (Dawson 1880). Recently Foster (1965) has assessed the status of the mammal and bird faunas. He indicates that of the seven mammalian species originally present, four are subspecifically distinct, and one, the extinct caribou deserved specific status. Among the birds there are three endemic subspecies. The invertebrates have not been thoroughly studied; however, Bousfield (1958) has described a new species of amphipod restricted to the islands. Calder and Taylor (1968) note 11 endemic taxa of vascular plants, over 2% of the total. Among the non-vascular plants there is apparently a similar high proportion of endemics (Scholefield, cited *in* Calder and Taylor, 1968). These studies suggest that, as on many islands, isolation and a different selective regime have contributed to divergence of the biota relative to mainland forms.

Studies of the freshwater fishes of the islands reveal atypical forms of the threespine stickleback (*Gasterosteus aculeatus*) as well. The purpose of this note is to outline the degree of differentiation in some of the stickleback populations and to draw attention to trends which could threaten the survival of some of them. Research on the sticklebacks of the Queen Charlotte Islands began in 1966 and the results of a study of sticklebacks in Mayer Lake are described by Moodie (1972a, b). A population in Boulton Lake is the subject of detailed study by one of us (T.E.R.). We and others have sampled over 24 additional lakes and streams and the results of that survey will be published shortly.

Although *G. aculeatus* is a variable species, generally the freshwater form known as *leiurus* (Figure 1A) is a thick bodied fish with three dorsal spines and one pair of ventral spines forming the major part of the pelvic fins. They lack scales but there is a series of lateral bony plates. The number of these plates usually ranges from four to 35 but the average in fresh water is about five to 10. The body color is pale yellow with irregular patches and stripes of olive and brown. For a detailed description of eastern Pacific coast sticklebacks and their variation, papers by Hagen (1967) and Hagen and Gilbertson (1972) should be consulted.

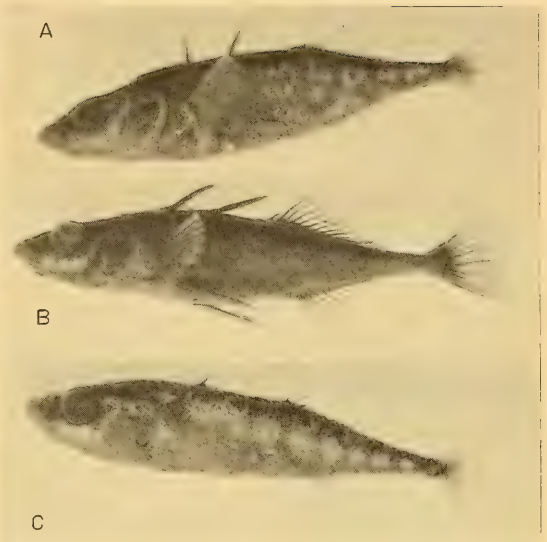

FIGURE 1. *Gasterosteus* from the Queen Charlotte Islands. (A) *Leiurus* from Woodpile Creek, in the Mayer Lake drainage, approximately 55 mm standard length; (B) "Black" specimen from Mayer Lake, approximately 70 mm standard length; (C) specimen from Boulton Lake lacking the second dorsal spine and both pelvic spines, approximately 50 mm standard length.

In the Queen Charlotte Islands many stickleback populations show variations in these characters which well exceed the normal range. In Mayer Lake, on Graham Island (largest of the Queen Charlotte Islands) there are two kinds of sticklebacks. Those inhabiting the three tributary streams of the lake are like the typical *leiurus* described above. In the lake proper there is a different form, termed the "Black" stickleback (Figure 1B). Black sticklebacks are nearly twice the length of *leiurus,* they are very melanistic, much more streamlined, and differ in at least six other morphometric and meristic traits. The Black stickleback appears to meet the criteria of the biologically defined species (Moodie 1972a, b).

There are at least three other lakes on Graham Island containing similar giant, melanistic stickleback populations. Because the typical *leiurus* form in the Queen Charlotte Islands tends to occur in restricted and hard-to-sample environments, we cannot say whether these other populations of

large melanistic sticklebacks exist parapatrically with *leiurus* as in Mayer Lake or not. However, in Drizzle Lake we have taken many large melanistic sticklebacks from the open water and from an inlet stream to the lake a very few smaller fish that may be the *leiurus* form.

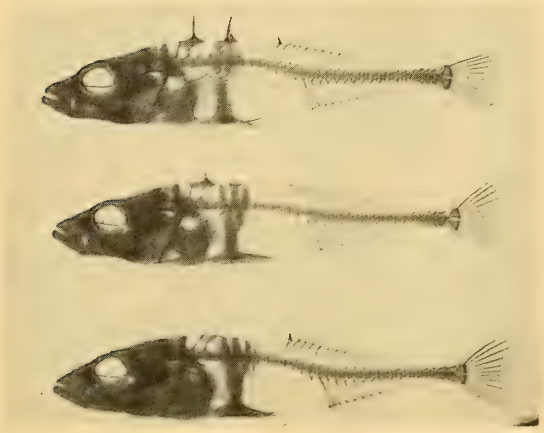

FIGURE 2. *Gasterosteus* from Boulton Lake, cleared and stained with alizarin red S. Upper specimen with all dorsal spines present: center specimen with second and third dorsal spines absent; bottom specimen with first and second dorsal spines absent.

In other lakes we have found unusual variation in spine number (Figure 2). In four lakes, one, two, or all three dorsal spines may be absent in 10 to 90% of the fish. In Boulton Lake the pelvic spines and girdle are polymorphic, so that the spines and virtually all of the girdle are absent in 70% of the individuals collected (Figure 1C). Such spine loss, even of very low percentages, is almost unheard of in extant forms of *Gasterosteus*. No instances are mentioned by Hagen and Gilbertson (1972) in their survey of the species on the west coast. We are unaware of significant loss of spines among the well studied *Gasterosteus* populations of Continental Europe. There is, however, a population in Lough Ree, County Roscommon, Ireland in which some individuals lack the first and second dorsal spine although the frequency is not known (David Marlborough, personal communication). The only comparable population that we know of in North America is on Texada Island, British Columbia, and is under study by J. D. McPhail and others. The lateral plates also show variation beyond the normal range. There are populations in three lakes in which most individuals completely lack plates. In other lakes most fish have only one or two plates per side. The only other localities of which we are aware, where such loss occurs are in southern California, Algeria (Miller and Hubbs 1969) and Texada Island (McPhail, personal communication).

In summary, there are populations of *G. aculeatus* in the Queen Charlotte Islands that show degrees of melanism, gigantism, spine loss, and lateral plate reduction, which are seldom or never exceeded elsewhere in this widely distributed coastal species. Although our investigation is incomplete and the causes of the peculiarities of the sticklebacks are far from understood, there are already some obvious correlations between their morphology and environmental variables. Most of the populations showing lateral plate reduction or spine loss occur in lakes with no outlets and apparently no other species of fish. The absence of both competitors and predators has seemingly allowed the sticklebacks to evolve novel adaptations to their ecologically unusual environments. In contrast, those lakes which contain salmonids and cottids are generally populated by larger sticklebacks with relatively long spines and higher numbers of plates.

This multitude of isolated populations, many of which display morphological variation almost unknown elsewhere, and all within modest distance of one another, offers a rare opportunity to study natural selection, competitive interactions, and predator–prey relationships. Consideration should be given to the maintenance of some of the more extraordinary populations. Fortunately, most lakes are inaccessible and the negative effects of civilization will not reach them for some time. However, this is not the case for a few lakes which also happen to contain the most unusual populations. Boulton Lake is situated within 200 m of the Masset – Port Clements highway. Because the loss of spines and lateral plates in this population appears to be a result of the absence of predators, the introduction of game fish such as trout would probably lead to the elimination of this distinctive population.

At present there is no need for trout introductions because native stocks meet the demands of fishermen. We spent the summers of 1967, 1968, and 1969 on Graham Island and were in the area for 1-month periods in 1970 and 1972. During that interval we saw an increase in trout fishing for sport and subsistence. Although the stickle-

back populations in Mayer Lake may not be adversely affected by such fishing, we fear overfishing in some lakes may lead to pressure to introduce game fish in lakes such as Boulton. Greater angling activity may also lead to introductions for the sake of the simple desire to have more different places to go fishing. The most serious threat to lakes which lack predators, such as Boulton, is that trout will be introduced by the private action of well meaning citizens. If game fish must be introduced we hope the introduction can be restricted to the many suitable lakes and drainages which presently lack fish of any sort.

In California the plateless sticklebacks were granted protection (Miller 1972) only after introductions had considerably altered the gene pool and environment (Miller and Hubbs 1969). In the Queen Charlotte Islands Foster (1965) suggests the extinction of the caribou may have been hastened by the introduction of deer. Surely adequate protection for at least some of the endemic sticklebacks of the Queen Charlotte Islands should be established before irreversible environmental changes occur.

We are most grateful to Alex E. Peden for reviewing the manuscript, for providing photographs, and for help in the field. Dr. Peden's contribution was financed by the British Columbia Provincial Museum. Our work was supported by grants from the National Research Council of Canada to J. R. Nursall and G. E. E. Moodie.

Literature Cited

Bousfield, E. L. 1958. Fresh-water amphipod crustaceans of glaciated North America. Canadian Field-Naturalist 72: 55–113.

Calder, J. A. and R. L. Taylor. 1968. Flora of the Queen Charlotte Islands. Part 1. Systematics of the vascular plants. Research Branch, Canada Department of Agriculture, Monograph Number 4, Part 1.

Dawson, G. M. 1880. Report on the Queen Charlotte Islands 1878. *In* Geological Survey of Canada, Report of Progress for 1878–1879. pp. 1B–239B.

Foster, J. B. 1965. The evolution of the mammals of the Queen Charlotte Islands, British Columbia. Occasional Papers of the British Columbia Provincial Museum, Number 14.

Hagen, D. W. 1967. Isolating mechanisms in threespine sticklebacks *(Gasterosteus)*. Journal of the Fisheries Research Board of Canada 24: 1637–1691.

Hagen, D. W. and **L. G. Gilbertson.** 1972. Geographic variation and environmental selection in *Gasterosteus aculeatus* L. in the Pacific Northwest, America. Evolution 26: 32–51.

Miller, R. R. 1972. Threatened freshwater fishes of the United States. Transactions of the American Fisheries Society 101: 239–252.

Miller, R. R. and C. L. Hubbs. 1969. Systematics of *Gasterosteus aculeatus*, with particular reference to intergradation and introgression along the Pacific Coast of North America: A commentary on a recent contribution. Copeia, 1969: 52–69.

Moodie, G. E. E. 1972a. Morphology, life history and ecology of an unusual stickleback *(Gasterosteus aculeatus)* in the Queen Charlotte Islands, Canada. Canadian Journal of Zoology 50: 721–732.

Moodie, G. E. E. 1972b. Predation, natural selection and adaptation in an unusual threespine stickleback. Heredity 28: 155–167.

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Is the Grey Squirrel Invading Nova Scotia?

While motoring through the village of Habitant, near Canning (Kings County, Nova Scotia) on the afternoon of November 5, 1972, I saw a Grey Squirrel (*Sciurus carolinensis*) running across the lawn on the property of Roy Hazel. Having no previous record for this species in Nova Scotia, I was greatly interested, and visited the area a few days later to make some enquiries. At the Hazel residence I was informed that the animal had been seen frequently during the previous several weeks and as far as anyone in the community knew, it had arrived there under its own 'steam.' Subsequently I called on others in the neighborhood and two told of having seen it running along an overhead telephone cable.

Still not completely satisfied that the squirrel was not an escaped pet, I enquired over our local radio station (CKEN) asking if anyone had lost

such an animal and if so to please contact me. During more than a month I received no calls. It was suggested that it might have escaped from the Provincial Wildlife Park, at Shubenacadie, Hants County. I wrote the superintendent of that institution and he replied in the negative.

Learning that an attempt had been made to catch the animal in a steel trap, I quickly employed a box trap, baited with peanuts, and soon caught the squirrel, which proved to be male. I placed it in a large 8 × 15 foot wire enclosure, with several tree stumps and brush. In addition it was given a copious supply of excelsior, cotton wool, and feathers from which it constructed a football-size nest with a neat entrance hole on the side. At first it was quite savage and succeeded in biting my finger. But it soon became quite tame and readily accepted food from my hand.

The first report of the grey squirrel in Nova Scotia appears to be that of A. L. Rand (1933, Canadian Field-Naturalist 47: 41–50) based on a sight record related to him of an animal seen in 1930 near Fisher's Lake, about 16 mi south of Annapolis Royal. Rand concluded . . . "It seems probable that these are escaped caged animals, brought to the province by tourists." Similar conclusions were reached by R. W. Smith (1940, American Midland Naturalist 24: 231), who cited Rand's original report. The same record is mapped by R. L. Peterson in his *Mammals of Eastern Canada* (Oxford University Press, 1966, pp. 108–109) without further comment.

Since grey squirrels have become established in a number of points in southern New Brunswick (see Peterson 1966), it seems reasonable to assume that the specimen reported here has emigrated from New Brunswick.

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A Northern Range Extension of the Four-toed Salamander in Ontario

The northern limit of the Four-toed Salamander, *Hemidactylium scutatum,* as given by E. B. S. Logier and G. C. Toner (1961. Check list of the amphibians and reptiles of Canada and Alaska. The Royal Ontario Museum Life Sciences Division Contribution 53. pp. 22–23) is delimited by collections from McGregor Bay, Manitoulin District, Ontario and Glen Eagle, Gatineau County, Quebec (just north of Ottawa).

On 6 August 1973, while on a canoe trip to the Montreal River in Temagami Provincial Forest, I had crossed Hunt Lake (due south of Matachewan, west of Elk Lake, between Sisseney and Shillington lakes: see Department of Surveys map Gogama 1:250,000). At the beginning of a rather mushy portage on a cool rainy day, I noticed and picked up a salamander wriggling in the sphagnum moss at the edge of the water. This individual was about 3 inches long and dull yellowish orange in color without evidence of stripes. It had a white underside with black spots, and four toes on each foot. Neither realizing its significance nor having a container at the time, I released it at the spot. Later, at the base camp, I identified it from R. Conant (1958. A field guide to reptiles and amphibians of the United States and Canada East of the 100th Meridian. Houghton Mifflin Company. 366 pp.) and realized that it was a northern range extension of about 100 miles.

Francis R. Cook, National Museum of Natural Sciences, has confirmed that the white underside with black spots distinguishes this species from all other Ontario salamanders. Only this species and the permanently aquatic Mudpuppy have four toes on the hind feet, all other Canadian species have five. All have four toes on each front foot.

This generally secretive, bog-breeding species is almost certainly more widespread than the few scattered northern specimens taken to date indicate.

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A Contribution to the Bryology of Southampton Island, Northwest Territories[1]

Abstract. Three liverworts and 50 mosses are reported from three localities on Southampton Island, Arctic Canada. Of these, one liverwort (*Chandonanthus setiformis*) and 12 mosses (*Andreaea rupestris, Bryum stenotrichum, Campylium arcticum, Conostomum tetragonum, Cyrtomnium hymenophylloides, C. hymenophyllum, Dicranoweisia crispula, Dicranum bonjeanii, D. muehlenbeckii, Fissidens osmundioides, Oncophorus virens,* and *Saelania glaucescens*) are new to the island's bryflora, which is now known to comprise 22 liverworts and 126 mosses.

There have been few published reports of bryophytes from Southampton Island, in the southern part of the Canadian Arctic Archipelago, since the publication of Steere's (1948) paper. A few records have been cited by Beckel and Irvine (1954), Cody (1951), Crundwell and Nyholm (1963), Kuc (1969), Persson and Holmen (1961), and Steere (1949). The total number of species reported in the above works is 21 liverworts and 114 mosses.

I recently identified a bryophyte collection made on Southampton Island in 1971 by Mr. G. R. Parker (Canadian Wildlife Service) as part of a survey on caribou ranges. This collection included one species of liverwort and 12 species of mosses previously unreported from Southampton Island. The known bryoflora of that island now stands at 22 species of liverworts and 126 species of mosses. There are undoubtedly many more species of bryophytes yet to be collected on Southampton Island, which because of its varied geology, soils, and topography must have a rich moss and liverwort flora.

In the following selectively annotated list an asterisk preceding a taxon indicates an addition to the Southampton Island flora. Voucher specimens are deposited in my personal herbarium and in the Bryophyte Herbarium of Memorial University (NFLD). Collection numbers CR-71-4 to CR-71-141, CR-71-153, and CR-71-154 are from Duke of York Bay (65°00′ N, 84°40′ W), numbers CR-71-142 to CR-71-146 from Bell Peninsula (63°53′ N, 81°05′ W), and numbers CR-71-148 and CR-71-152 from Kirchoffer River (64°40′ N, 84°14′ W). In the list the designation "CR-71" preceding each collection number is omitted.

[1]Studies in Biology from Memorial University of Newfoundland, No. 343.

Liverworts (Hepaticae)

Blepharostoma trichophyllum (L). Dum. ssp. *brevirete* (Bryhn & Kaal.) Schust. 131. In late snow bank area, with heavy *Cassiope* cover.

**Chandonanthus setiformis* (Ehrh.) Lindb. 97. On slopes of Precambrian Plateau (300 m), in lichen-*Vaccinium–Cassiope* complex.

Ptilidium ciliare (L.) Hampe. 80. In moss-sedge run-off meadow on Precambrian plateau (ca. 300 m).

Mosses (Musci) (in taxonomic order of Crum *et al.* 1965).

**Andreaea rupestris* Hedw. 5 (with sporophytes). Wet stream edge, calcareous soil. An unusual habitat for this acidophilic species.

**Fissidens osmundioides* Hedw. 131, 133. In late snow bank area, with *Cassiope,* and in poorly vegetated site.

Ditrichum flexicaule (Schwaegr.) Hampe. 80, 84, 85, 87, 101, 111, 113, 115, 128, 131, 141, 154. In a variety of habitats, both calcareous and non-calcareous.

**Saelania glaucescens* (Hedw.) Broth. 108. On a steep Precambrian slope, adjacent to the lowlands. This is the first report of this species from the Southampton region, but the species has been collected in the Hudson Bay region and in the continental Northwest Territories.

Distichium capillaceum (Hedw.) B.S.G. 113, 130, 140, 154 (all with sporophytes).

**Dicranoweisia crispula* (Hedw.) Milde. 5 (with sporophytes). On calcareous soil near wet stream edge. An unusual habitat for this species.

**Oncophorus virens* (Hedw.) Brid. 132. In late snow area with heavy *Cassiope.*

The genus *Dicranum* is notoriously difficult in arctic regions (Brassard 1971) and until a regional monograph is undertaken determinations must be considered preliminary.

**Dicranum bonjeanii* Lisa. 101. West-facing gneitic outcrop within calcareous lowlands.

Dicranum elongatum Schwaegr. 70, 77, 79, 152.

Dicranum fuscescens Turn. 82, 148.

Dicranum groenlandicum Brid. 74, 95, 97, 141, 154.

**Dicranum muehlenbeckii* B.S.G. 128, 132.

Encalypta alpina Sm. 118 (with sporophytes). Vertical cliff face on Precambrian plateau (350 m).

Tortella arctica (H. Arnell) Crundw. & Nyh. 95, 111, 128. All three specimens from the northern part of the island. Although *T. tortuosa,* the southern "vicariant" of the high arctic *T. arctica,* also occurs on Southampton Island (see below) specimens are easily assigned to one or the other species, with absolutely no intergrading forms.

Tortella fragilis (Drumm.) Limpr. 108, 115, 118, 133, 153.

Tortella tortuosa (Hedw.) Limpr. 132, 146. From two widely separated localities. This is among the most northern stations of *T. tortuosa* in Arctic Canada and this southern species' occurrence on Southampton Island is now confirmed.

Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb. 84, 113, 118.

Grimmia apocarpa Hedw. var. *apocarpa*. 101 (with sporophytes). On West-facing gneitic outcrop within calcareous lowlands.

**Grimmia apocarpa* Hedw. var. *stricta* (Turn.) Hook. & Tayl. 79. On exposed moss–sedge meadow on Precambrian plateau (350 m).

Rhacomitrium lanuginosum (Hedw.) Brid. 33, 70, 71, 72, 77, 79, 82, 95, 97, 101, 103, 132, 141, 142, 146, 148, 154. One of the most abundant species in this collection.

Tetraplodon mnioides (Hedw.) B.S.G. 142 (with sporophytes).

**Bryum stenotrichum* C.Müll. 85 (with sporophytes). On calcareous polygonal slope with poor drainage.

Mnium orthorrhynchum Brid. 132, 146.

**Cyrtomnium hymenophylloides* (Hüb.) Nyh. 140, 154. In poorly-drained calcareous polygonal tundra and on steep well-vegetated slope of Precambrian plateau.

**Cyrtomnium hymenophyllum* (B.S.G.) Holmen. 128. In protected wet sedge–moss–willow meadow at base of Precambrian plateau.

Cinclidium arcticum Schimp. 128.

Aulacomnium acuminatum (Lindb. & H. Arnell) Par. 71, 79, 128. A high arctic moss near the southern limit of its distribution.

Aulacomnium palustre (Hedw.) Schwaegr. 128 (with propagula).

Aulacomnium turgidum (Wahlenb.) Schwaegr. 95. Moss–sedge–willow complex on Precambrian plateau (300 m).

Meesia trifaria Crum, Steere & Anderson. 143. Wet sedge–willow bog within calcareous lowlands.

Meesia uliginosa Hedw. 141, 142. In flat gneitic areas within calcareous lowlands at both localities.

Catoscopium nigritum (Hedw.) Brid. 71, 128, 143.

**Conostomum tetragonum* (Hedw.) Lindb. 152 (with sporophytes). On lichen-covered shingle with good drainage; Precambrian parent material.

Timmia austriaca Hedw. 82. On exposed poorly-vegetated slope.

Timmia norvegica Zett. 77, 108. On boulder-strewn Precambrian plateau (350 m) and well-drained slopes adjacent to the lowlands.

Orthotrichum speciosum Sturm. 97, 101, 130 (all with sporophytes), 154.

Myurella julacea (Schwaegr.) B.S.G. 72, 108, 111, 140, 146.

Myurella tenerrima (Brid.) Lindb. 77, 131.

Abietinella abietina (Hedw.) Fleisch. 103, 130, 131. The range of this species in the Canadian Arctic Archipelago has been recently mapped by Kuc (1969).

**Campylium arcticum* (Williams) Broth. 143. In wet sedge-willow bog within calcareous lowlands.

Drepanocladus brevifolius (Lindb.) Warnst. 143.

Drepanocladus uncinatus (Hedw.) Warnst. 108, 142. On steep Precambrian slopes and on gneitic bedrock surrounded by calcareous lowlands.

Tomenthypnum nitens (Hedw.) Loeske. 110, 111, 131, 132.

Brachythecium turgidum (C. J. Hartm.) Kindb. 108, 113. On steep slopes of Precambrian plateau.

Orthothecium chryseum (Schultes) B.S.G. 128, 143. In wet meadow at base of Precambrian plateau and in bog within calcareous lowlands.

Hypnum bambergeri Schimp. 4, 77, 84, 85, 87, 113, 131.

Hypnum revolutum (Mitt.) Lindb. 113, 146. On steep slopes of Precambrian plateau and gravel-covered slope bordering calcareous lowlands.

Rhytidium rugosum (Hedw.) Kindb. 74, 130, 141.

Hylocomium splendens (Hedw.) B.S.G. 80, 101, 103, 132.

Polytrichastrum alpinum (Hedw.) G. L. Smith. 108, 133.

Polytrichum juniperinum Hedw. var. *juniperinum*. 97, 152. On slopes of Precambrian plateau (300 m), and lichen-covered shingle with good drainage.

Polytrichum juniperinum Hedw. var. *gracilius* Wahlenb. 70. On Precambrian outcrop in calcareous lowlands.

I wish to thank Mr. G. R. Parker for sending me the specimens and for permission to publish the records.

Literature Cited

Beckel, D. K. B. and **B. E. Irvine.** 1954. Botanical studies at Duke of York Bay, Southampton Island, Northwest Territories, Canada. Defence Research Northern Laboratory Technical Paper 25. 37 pp.

Brassard, G. R. 1971. The mosses of northern Ellesmere Island, Arctic Canada. II. Annotated list of the taxa. Bryologist 74: 282–311.

Cody, W. J. 1951. Additions and annotations to the flora of Southampton Island, Northwest Territories, Canada. Canadian Field-Naturalist 65: 140–143.

Crum, H., W. C. Steere and **L. E. Anderson.** 1965. A list of the mosses of North America. Bryologist 68: 377–432.

Crundwell, A. C. and **E. Nyholm.** 1963. Notes on the genus *Tortella*. II. *Tortella arctica*. Bryologist 66: 184–191.

Kuc, M. 1969. Additions to the Arctic moss flora — I. Revue Bryologique et Lichénologique 36: 635–642.

Persson, H. and **K. Holmen.** 1961. Bryophytes collected during the Arctic field trip of the Ninth International Botanical Congress. Bryologist 64: 179–198.

Steere, W. C. 1948. Musci. *In* Botany of the Canadian Eastern Arctic. Part 2. Thallophyta and Bryophyta. National Museum of Canada Bulletin 97: 370–490.

Steere, W. C. 1949. Bryophyta of Arctic America. III. The rediscovery of *Funaria polaris* Bryhn. Bryologist 52: 29–32.

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Laysan Albatross, Scaled Petrel, Parakeet Auklet: Additions to the List of Canadian Birds

Until recently, very little was known about pelagic birds in the littoral waters off the west coast of Canada. Martin and Myres (1969) summarized observations of seabirds along the west coast of Vancouver Island during the spring and summer months for the period 1946 to 1949. Beginning in 1970, pelagic birding trips in spring, summer, and fall were held from Tofino, British Columbia under the sponsorship of the Vancouver Natural History Society. The observations made during these trips have been summarized by Campbell and Shepard (1971, 1972). Other information has been gathered during periodic offshore trips by biologists on various research vessels. The purpose of this note is to summarize information concerning three pelagic birds, namely the Laysan Albatross (*Diomedea immutabilis*), Scaled Petrel (*Pterodroma inexpectata*), and Parakeet Auklet (*Cyclorhynchos psittacula*), all of which are new to the list of Canadian birds. The limit for Canadian records is considered to be 40 miles offshore, following W. E. Godfrey (personal communication).

Photographs have been obtained to substantiate the sightings of two species (Laysan Albatross and Scaled Petrel). These have been deposited in the Photoduplicate File of British Columbia Vertebrate records (Campbell and Stirling 1971), referred to as PDF hereafter, which is now housed in the British Columbia Provincial Museum in Victoria. Copies have been deposited also in the National Collection of Nature Photographs at the National Museums of Canada in Ottawa.

Laysan Albatross

During September, 1968, while fishing at the edge of La Perouse Bank (about 50 miles offshore), the crew and technicians of the Fisheries Research Board ship, *G. B. Reed,* saw a Laysan Albatross near the ship. The observers were familiar with the species, having often cruised the Gulf of Alaska, where the bird is common.

On 17 August 1970 this species was observed by Shepard about 25 miles off Ucluelet, Vancouver Island (48°26′ N. 125°40′ W). The albatross followed the *G. B. Reed* for about 10 min, approaching within 100 feet of the ship. Field notes describing the identification are on file in the British Columbia Provincial Museum.

The following winter, while on board the CNAV *Endeavor,* Campbell saw and photograhed a Laysan Albatross on 23 February 1971, approximately 175 miles off the Olympic Penninsula, Washington. The next day, at a point about 100 miles to the north, the same or another bird was photographed (PDF 149; photograph also published in *American Birds* 25: 615, 1971), just 25 miles off Estevan Point, mid-way up Vancouver Island.

On 22 June 1971, Spencer Sealy (personal communication) saw four white-bodied albatrosses over Parry Passage between Langara Island and Graham Island in the Queen Charlotte Islands. It is likely that these were *D. immutabilis* rather than the very rare short-tailed Albatross (*D. albatrus*), the only other similar species of regular occurrence in the North Pacific.

On the Cook Bank, about 5 miles off the northern end of Vancouver Island, an adult Laysan Albatross was observed by Campbell on 26 October 1971. The following day, as many as three were seen at one time, near the ship CSS *Parizeau* as it travelled south off the west coast of Vancouver Island. Again photographs were obtained (PDF 225).

Laysan Albatrosses usually occur much farther offshore along the British Columbia and Washington coast in fall. The only August sightings reported by Sanger (1970) were more than 750 miles from shore, and a trip in August, 1968 (Shepard, unpublished manuscript) recorded that all sightings were more than 300 miles from shore. This species moves much closer to land in winter along our coast, probably following the shift in the coldwater belt. We can consider the species a rare but a regular winter visitor to the British Columbia coast, and occurring casually at other seasons.

Scaled Petrel

On 23 February 1971, at 1755 hours, a Scaled Petrel was seen by Campbell about 175 miles west of the Olympic Penninsula, Washington (48°00′ N, 127°22′ W). Detailed field notes were made as the bird was watched within 30 feet of the ship. The following morning, a bird was found on board the CNAV *Endeavor* by crew member Jim McCormick about 15 miles off Flores Island, Vancouver Island (49°14′ N, 127°01′ W). The bird was photographed (PDF 150; *American*

Birds 25: 615, 1971) and released. It was attacked by Glaucous-winged Gulls (*Larus glaucescens*) and Herring Gulls (*L. argentatus*) but managed to escape.

Mention should also be made here of a Scaled Petrel which was found dead on board the ship *Naess Pioneer* by D. H. Mobberley on 17 March 1972 about 315 miles off the Queen Charlotte Islands (51°23′ N, 140°54′W). The specimen was kindly donated to the Vertebrate Museum at the University of British Columbia in Vancouver, where it is catalogued as Number 13685.

This visitor from southern oceans is probably of casual occurrence along the British Columbia coast.

Parakeet Auklet

On 24 February 1971 this species was observed on three occasions by Campbell while aboard the ship CNAV *Endeavor* about 15 miles off the central west coast of Vancouver Island. At 0830 hours one scampered out from behind a scrub pail along the deck and escaped before it could be caught. The bird was contrastingly dark above and light below, the short dark bill appeared rounded, and a light supercilliary line was noticed. Twenty-five minutes later another bird was seen about 35 feet from the ship and at 0920 hours a third bird was seen. No photographs were obtained.

The status of this species off the west coast of Canada needs further clarification. This Alaskan bird may indeed be a regular winter visitor to the British Columbia coast, especially since it has been recorded in Washington and Oregon (Jewett *et al.* 1953; Gabrielson and Jewett 1940, p. 317).

Literature Cited

Campbell, R. W. and **M. G. Shepard.** 1971. Summary of spring and fall pelagic birding trips from Tofino, British Columbia. Discovery 150: 13–16. (published by the Vancouver Natural History Society.)

Campbell, R. W. and **M. G. Shepard.** 1972. Summary of 1971 offshore birding trips. Discovery 154: 7–8.

Campbell, R. W. and **D. Stirling.** 1971. A photoduplicate file for British Columbia vertebrate records. Syesis 4: 217–222.

Gabrielson, I. N. and **S. G. Jewett.** 1940. Birds of the Pacific Northwest. Oregon State College, Corvallis.

Jewett, S. G., W. P. Taylor, W. T. Shaw, and **J. W. Aldrich.** 1953. Birds of Washington State. University of Washington Press, Seattle.

Martin, P. W. and **M. T. Myres.** 1969. Observations on the distribution and migration of some seabirds off the outer coasts of British Columbia and Washington State. Syesis 2: 241–256.

Sanger, G. A. 1970. The seasonal distribution of seabirds off Washington and Oregon, with notes on their ecology and behaviour. Condor 72(3): 339–357.

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Unequal Distribution of Snowy Owls on Eastern Melville Island, Northwest Territories

An aerial survey of Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) on eastern Melville Island was made by helicopter during August 1972. The Dundas Peninsula and all of Melville Island east of the central constriction formed by the head of Liddon Gulf on the south and the southeast corner of Hecla and Griper Bay on the north (111°00′ W) was flown over on a 6.4 km transect grid. Because of personal interests, we recorded all raptorial birds along the transect lines. Snowy Owls (*Nyctea scandiaca*) are readily detectable from a helicopter, and we believe that most owls within the survey strips were observed.

Eastern Melville Island was divided into six strata that corresponded to the boundaries of the major geographical land units (Figure 1). All survey flights were flown 165 m above ground level at speeds averaging about 130 kph. Observations were recorded on 6.4-km (4-mile) to-the-inch maps and described on audio tape. It required 8 days, between August 7 and 25, to fly 3,700 km of transect lines. A strip 0.8 km wide was surveyed by an observer on each side of the helicopter. A total area of about 6,000 km^2 was surveyed, constituting about 24% of eastern Melville Island.

TABLE 1. — Observed distribution and estimated numbers of Snowy Owls on eastern Melville Island, Northwest Territories in July 1961 and August 1972.

Stratum[a]	Owls observed		Area surveyed (km²)		Total area (km²)		Estimated owls on stratum	
	1961	1972	1961	1972	1961	1972	1961	1972
I, II	3	0	290	1,170	4,670		48	0
IV	0	2	440	1,820	7,250		0	8
VI	36	20	310	1,380	5,610		652	89
Totals	39	22	1,038	4,370	17,530		700	97

[a]See Figure 1.

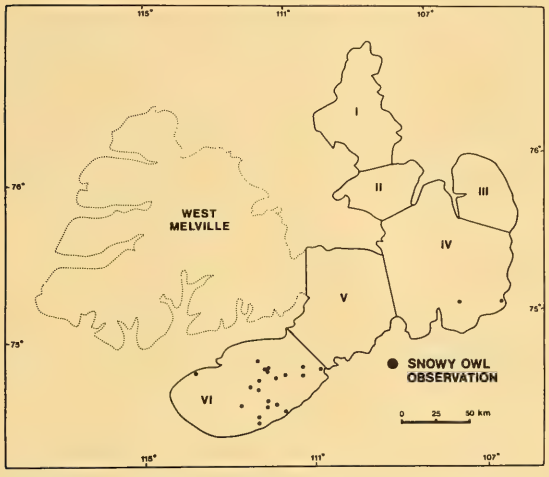

FIGURE. 1. Observed distribution of Snowy Owls on eastern Melville Island, Northwest Territories, August 1972.

The resultant observations revealed a very unequal distribution of Snowy Owls by strata (Table 1). Stratum VI (Figure 1), 23% of the entire land mass, held 91% of the observed Snowy Owls. The south coast of stratum IV contained the other two snowy owls observed. None was observed within strata I, II, III and V — an area of about 11,200 km² or 47% of the survey area. In total, over two-thirds of the surveyed portions of eastern Melville Island were without Snowy Owls.

Tener (Tener, J. S. 1963. Queen Elizabeth Islands game survey, 1961. Canadian Wildlife Service, Occasional Paper No. 4. 50 pp.) surveyed eastern Melville Island from the air in July 1961. He saw 36 Snowy Owls on the Dundas Peninsula (stratum VI), 3 on the Sabine Peninsula (strata I and II), and none on the rest of eastern Melville Island, (strata III, IV, and V). A comparison of the 1961 and 1972 observations is given in Table 1.

The density of Snowy Owls observed in stratum VI in 1972 (1 owl/69 km² or 1 owl/26.6 mi²) is low compared to observations made by Manning et al. (Manning, T. H., E. O. Hohn, and A. H. Macpherson. 1956. The birds of Banks Island. National Museum of Canada Bulletin 143, p. 106). They saw 1 Snowy Owl/mi² and 1/10 mi² during 2 consecutive years on the same area of Banks Island. Tener's (1963) 1961 observation of 1 owl/8.6 mi² on the Dundas Peninsula is within the range of densities reported by Manning *et al.* (1956).

The variation in estimated populations of Snowy Owls in 1961 and 1972 suggests that 1972 was a low period in Snowy Owl occurrence on eastern Melville Island. The observed distribution of Snowy Owls in both 1961 and 1972 indicates that the Dundas Peninsula is a favored habitat.

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The Yellow-breasted Chat in Quebec

In eastern Canada, the Yellow-breasted Chat (*Icteria virens*) breeds only in southern Ontario and is of casual occurrence elsewhere, having been reported, mostly in fall and winter, in New Brunswick, Nova Scotia, and Newfoundland (Godfrey 1966, p. 346).

At present, there are only a few known records of the species in Quebec. All were obtained in the fall. In 1962, an individual bird was identified by Mrs. R. Cooper on 12 September in Town of Mount Royal (Montreal); another individual, possibly the same bird, was observed about a mile from the first sighting (no date given), also by reliable observers (Annual Report of the Province of Quebec Society for the Protection of Birds 1962, p. 32; Carleton 1963, p. 18). A Yellow-breasted Chat, possibly the bird seen previously, was reported from the same locality on 29 and 30 September by Mr. Jean Boulva and other reliable observers (Cayouette 1963, p. 5; Carleton 1963, p. 18).

On 30 September 1962, another Yellow-breasted Chat was reported at Lévis by Mr. Gérard Harvey and colleagues (Cayouette 1963, p. 5; Carleton 1963, p. 18).

On 12 September 1971, a specimen was found dead in Chicoutimi by Miss Johanne Tremblay and sent to the National Museum of Natural Sciences through the courtesy of Mr. Peter Browne of Arvida, Quebec. Apparently the bird had died after it had hit a picture window. It was a bird of the year (skull not fully ossified) in the first non-nuptial plumage. The specimen (Catalogue number, NMC 57740) was rather fat and in good condition.

I have identified it as belonging to the eastern subspecies *I. virens virens* on the basis of its measurements (chord of the wing, 74.9 mm; tail, 76.7 mm; exposed culmen, 14.0 mm) and of its coloration pattern, which differs appreciably from that of the western subspecies, *I. virens auricollis.*

Literature Cited

Anonymous. 1962. Province of Quebec Society for the Protection of Birds, Annual Report for 1962. pp. 1-39.

Carleton, G. 1963. Hudson – St. Lawrence Region. Audubon Field Notes 17(1): 18.

Cayouette, R. (editor). 1963. Bulletin ornithologique 8(1): 1-9.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

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Yellow-billed Loon on Lesser Slave Lake, Alberta: A New Record

The Yellow-billed Loon *(Gavia adamsii)* is circumpolar in distribution. In Canada it nests on tundra lakes from about 61° N on the west side of Hudson Bay to nearly 75° N on Banks Island. The Canadian population winters primarily along the coast of Southeastern Alaska and extreme Northwestern British Columbia. The main migration route is believed to be coastal, around Alaska via Bering Strait. However, birds occur regularly inland in spring and fall as far south as Great Slave Lake (61°–63° N, 110°–117° W); and have occasionally been recorded at Atlin (59° N, 134° W), British Columbia and Fond du Lac (59° N, 107° W), Saskatchewan (Godfrey 1966). There is also a remarkable record of an immature collected in early November, 1922, near Brighton (40° N, 105° W), Colorado (Bailey and Lincoln 1954). For a long time both the wintering areas and migration routes of this species in North America were unknown (Bent 1919; Cooke 1915). Even today, the migration routes are poorly understood.

On June 22, 1972 my husband and I were on a brief visit to Lesser Slave Lake Provincial Park, Alberta (55°30′ N, 114°45′ W). The park is at the east end of the lake, and when we walked down to the shore, we spotted a loon swimming

less than 200 feet out. I assumed it to be a Common Loon (*Gavia immer*), but a check with field glasses immediately revealed that it was, in fact, a Yellow-billed Loon. The pale beak, with its sharply angled lower mandible, was conspicuous and diagnostic. I further observed the large white spots on the back and wings characteristic of the adult breeding plumage. The loon seemed appreciably bigger than the Common Loons we had been watching a short time earlier, although none happened to be in the immediate vicinity at the time. The Yellow-billed Loon was silent, but its behavior seemed normal. It spent its time swimming slowly, peering into the water, and occasionally diving.

Unfortunately, I had left my telephoto lens in the car, and by the time this was retrieved the loon had moved some distance from shore.

On returning to Edmonton I immediately contacted Mr. Dave Spalding, Head Curator of Natural History at the Provincial Museum. He accepted my identification, and informed me that this was the first report of the Yellow-billed Loon in Alberta as far as he knew. He visited the same site on June 26 but was unable to find the Yellow-billed Loon.

Since the loon was apparently in adult breeding plumage, it seemed surprising for it to be so far south in late June. I thought it might be a subadult in near-adult plumage, but not yet breeding; and W. Earl Godfrey (personal communication) considers this the most probable explanation.

Literature Cited

Bailey, A. M. and **F. C. Lincoln.** 1954. The Yellow-billed Loon (*Gavia adamsi*) in Colorado. Auk. 71: 203.

Bent, A. C. 1919. Life histories of North American diving birds. Dover Publications, Inc., N.Y.

Cooke, W. W. 1915. The Yellow-billed Loon: a problem in migration. The Condor XVII(6): 213–214.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

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An Unfortunate Misquotation of the Literature on Caribou

In the illustrated book "Tuktu" (Symington, Fraser. 1965. Tuktu, a question of survival. Queen's Printer, Ottawa. 92 pp.), the author discusses predation on barren-ground caribou *(Rangifer tarandus)*. On page 38 he quotes A. W. F. Banfield (1954. Preliminary investigation of the barren-ground caribou. Canadian Wildlife Service, Wildlife Management Bulletin Series 1, No. 10B, 112 pp.) as follows: "Banfield reported finding 113 carcasses within a mile or so of each other on an open lake." The pertinent section in Banfield's paper (p. 51) states the following: ". . . on April 24, 1949, 20 wolves were observed associated with a herd of approximately 100,000 caribou on Ghost Lake. From that point the migration route was traced back to Lac la Martre. Along the route 113 caribou carcasses were observed on the ice of the lakes. Several wolves were seen feeding upon these carcasses. Probably more carcasses were hidden in the timber. From other records the herd was believed to have taken about a month to travel this distance." The distance from Ghost Lake to Lac la Martre in a straight line is between 70 and 90 miles. Assuming that the caribou herd travelled via the shortest route between the two points, the concentration of caribou carcasses would approximate 1.4 carcasses per mile, which conveys quite a different impression than the quotation given by Symington above.

Symington has been quoted recently by the Jack Miner Migratory Bird Foundation in a widely distributed pamphlet entitled "Vilhjalmur Stefanson and Jack Miner" which advocates the destruction of wolves in Ontario. Unfortunately, much false information is found in the literature and tends to persist or to be amplified in subsequent publications. This note, publication of which was suggested by Dr. D. H. Pimlott, will serve to set one such record straight.

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Underwater Observation of a Green Moray, *Gymnothorax funebris*, in Baie des Chaleurs, New Brunswick

On 10 August, 1972, while doing an underwater biological survey at Belledune, 15 miles northwest of Bathurst, New Brunswick, a green moray *Gymnothorax funebris* Ranzani was observed. This fish was seen 400 feet east of Belledune Fertilizer outlet and 300 feet north of the wharf at a depth of 20 feet. Immediately after I had reached the bottom during a scuba diving operation, a 3- to 4-foot-long green moray swam toward me and stopped a few feet away for a few moments, then it fled towards deeper water. This lapse of time was enough to identify the fish positively. Being acquainted with green moray for several years at the Montreal Aquarium, the author is positive that the fish was not an American eel of yellow or green color. The absence of pectoral fins on the fish observed, the presence of canine teeth and the dorsal fin beginning over the head (not two-thirds of the distance from snout to anal fin) are the morphological characters which were observed to distinguish between the two species. The color was a brilliant green, and the characteristic circular gill openings and the typical breathing movement of the green moray were also seen clearly.

The visibility at the time of the observation was approximately 10 feet. On the previous days, readings of 16 feet were recorded by the use of a secchi visibility disk (oceanographic model). The surface temperature in Belledune area was 18°C and 10°C at 35 feet deep. At the site of the observation, at a 20-foot depth, the temperature was 16°C.

The peculiarity in this observation is the abnormal geographical range for this fish. Only one Canadian record of this species is known from a speared moray at Eastern Passage, Halifax harbour, Nova Scotia in August 1952 (Leim and Day 1959; Leim and Scott 1966). This present observation is thus of particular interest, and with the Nova Scotia report, a possible range extension during summer months is foreseen for this fish along the Canadian Atlantic Coast and the Gulf of St. Lawrence.

Despite the displacement from its natural habitat (normal range New Jersey and Bermuda to Rio de Janiero, Brazil including the Central American Coast (Böhlke and Chaplin 1968)), the green moray observed looked perfectly healthy and probably remained in this habitat because of the existence of a gypsum bed which, as far as particle size is concerned, resembles coral sand. This area also has an abundance of crevices between large rocks which make up the 1-mile-long wharf. These rocks are completely covered with sea urchins and starfish down to the bottom at 37 feet. Crabs and lobsters are also abundant in the area. Ballast water dicharge from ships from Florida could possibly be the source of introduction.

Literature Cited

Böhlke, J. E. and **C. C. G. Chaplin.** 1968. Fishes of the Bahamas. Academy of Natural Science of Philadelphia. Livingston Publishing Co., Wynnewood, Pa. 771 pp.

Leim, A. H. and **L. R. Day.** 1959. Records of uncommon and unusual fishes from eastern Canadian waters, 1950–58. Journal of the Fisheries Research Board of Canada 16(4): 503–514.

Leim, A. H. and **W. B. Scott.** 1966. Fishes of the Atlantic Coast of Canada. Fisheries Research Board of Canada, Bulletin No. 155. 485 pp.

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Great Gray Owl Captures Vole by means of Bill

Abstract. An observation is reported of a Great Gray Owl capturing a vole by means of its bill. A comparison of this observation with reports in the literature suggests this was a deviation from usual prey-caputure behavior and arose in response to a particular opportunity.

Although the Great Gray Owl (*Strix nebulosa*) is traditionally considered to be a poorly-known bird (e.g., Halliday 1959, pp. 65–70), a number of recent studies have been conducted at the nest (e.g., Parmelee 1968; Nero 1970, 1971), on the

wintering grounds (e.g., Godfrey 1967; Nero 1969; Brunton and Pittaway 1971), or both (Höglund and Lansgren 1968). These studies have added considerably to our knowledge of many aspects of this bird's life history.

Probably the best documented aspect is its diet. Although the Great Gray Owl has been recorded to eat a variety of food items (Bent 1938, p. 216), an overwhelming amount of evidence suggests that it eats mainly small mammals, especially mice and voles (Bent 1938, p. 216; Craighead and Craighead 1956; Law, 1960; Godfrey 1967; Höglund and Lansgren 1968; Nero 1969; Brunton and Pittaway 1971). These small mammals are usually under the snow in winter, but this owl appears to be particularly adapted to capturing them there, as it can apparently hear them under the snow (Law 1960; Höglund and Lansgren 1968; and others). Moreover, there are several observations of it thrusting its talons beneath the snow, thus capturing its prey (in one case under 8 inches of soft snow (Godfrey 1967)). All reported observations that we have seen refer to capture of the prey by means of the feet, as would be expected if the owl was to capture its prey under snow. Thus Nero's (1971, p. 26) statement that the prey are captured with the feet, and later transferred to the bill, is well supported by the literature. Furthermore, Nero (personal communication) recalls no incident of seeing a Great Gray Owl capture prey by means of its bill. However, he has observed it to use the bill to take mice from other owls in food exchanges, and a female took voles with her bill from the end of a stick proferred to her.

Therefore, an observation by us of such an event seems worth reporting. On December 1, 1968 while we were looking for Great Gray Owls with Robert R. Taylor in southeastern Manitoba during the 1968–69 influx there (Nero 1969), we observed an owl in a tree beside the Trans Canada Highway approximately 1 mile west of Falcon Lake. We stopped at 1555 C.S.T., as it was starting to grow dark, and while Taylor prepared for a banding attempt we watched the owl hunting. At 1600 C.S.T., it moved to a perch about 5 feet off the ground in a dead spruce, and appeared to be intently watching a vole (probably *Clethrionomys* or *Microtus*), which was moving about on top of the snow, sometimes in the open, sometimes under small branches. After approximately 2 min of this intense watching, the owl dived off the perch, headfirst, wings halfspread and back, and grabbed the vole with its bill, then landed about 3 feet beyond the spot where the vole had been. The owl remained on the ground for 30 seconds or less, then returned to the spruce, and transferred the vole to the talons of its right foot. Shortly thereafter, it flew north into a large poplar, and then, on Taylor's approach, flew north out of sight into the forest.

The fact that the vole was above the snow cover for some time suggests that the owl's apparent deviation from the usual method of capturing prey was in response to a particular opportunity. Great Gray Owls may use this method of capturing prey when voles come to the surface of ventilation shafts, or at times when there is little or no snow to conceal the prey.

We would like to thank W. Earl Godfrey and Robert W. Nero for comments on the manuscript, and Robert R. Taylor for participation in the outing.

Literature Cited

Bent, A. C. 1938. Life histories of North American birds of prey. Part 2. United States National Museum Bulletin 170. Dover edition, 1961. x + 482 pp.

Brunton, D. F. and **R. Pittaway, Jr.** 1971. Observations of the Great Gray Owl on winter range. Canadian Field-Naturalist 85: 315–322.

Craighead, J. J. and **F. C. Craighead, Jr.** 1956. Hawks, owls, and wildlife. Stackpole Company and Wildlife Management Institute. Dover edition, 1969. xi + 443 pp.

Godfrey, W. E. 1967. Some winter aspects of the Great Gray Owl. Canadian Field-Naturalist 81: 99–101.

Halliday, H. M. 1959. Adventures among birds. Thomas Allen Ltd., Toronto. 179 pp.

Höglund, N. H. and **E. Lansgren.** 1968. The Great Grey Owl and its prey in Sweden. Viltrevy (Stockholm) 5: 363–416.

Law, C. 1960. The Great Gray Owl of the woodlands. Blue Jay 18: 14–16.

Nero, R. W. 1969. The status of the Great Gray Owl in Manitoba, with special reference to the 1968–69 influx. Blue Jay 27: 191–209.

Nero, R. W. 1970. A visit to a Great Gray Owl nest. Ontario Naturalist 8(4): 4–7.

Nero, R. W. 1971. Spirit of the boreal forest: the Great Gray Owl. Beaver, Outfit 302(2): 25–29.

Parmelee, D. F. 1968. Nesting of the Great Gray Owl. Blue Jay 26: 120–121.

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AN APPRECIATION: GEORGE HARRISON TURNER 1877-1970

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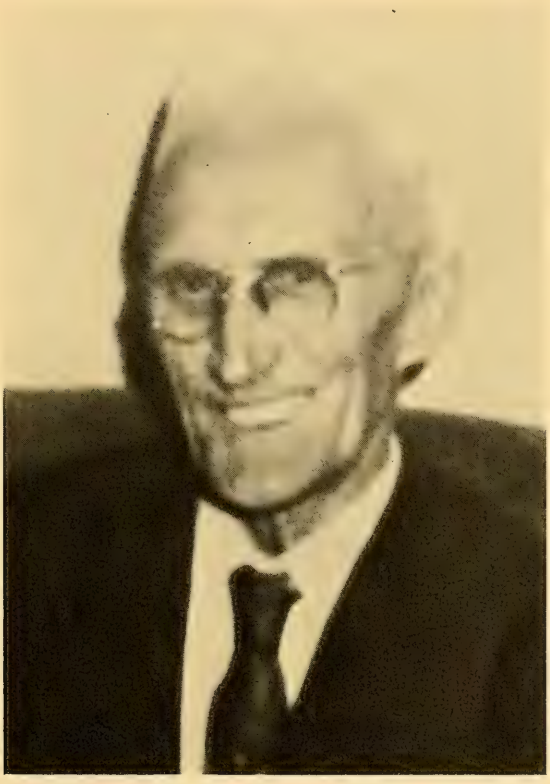
Canadian botanists are not an abundant species and the passing of none should occur without an appreciation of their contribution. Among the



pioneers of western Canadian botany, George Harrison Turner enjoys an honourable eminence. His collections over 60 years, mainly in the province of Alberta, were in excess of 12,000 and included both vascular and non-vascular plants. The collections were made predominantly from 1930 onwards, and Dr. Turner was still adding to their number when he was past 90 years of age. He provided, along with Dr. W. C. McCalla and Dr. E. H. Moss, the essential material for the latter's 'Flora of Alberta', published in 1959. Dr. Turner's collections of vascular plants are now deposited in the University of Alberta herbarium and the non-vascular plants were donated to the University of Calgary. His duplicates, however, were widely distributed and his collections are to be found in all the major herbaria of North American.

G. H. Turner was born in Baie Verte, New Brunswick, on June 26, 1877. Following attendance in public schools, he entered Mt. Allison University and graduated with a B.A. in 1899. He went on to McGill University and obtained his medical degree in 1903. In 1904 he moved to Fort Saskatchewan, Alberta, engaged in the practice of medicine, and remained there for the rest of his life. He died on September 13, 1970. His wife, the former Florence Yould, whom he married in 1906, predeceased him in 1949. Two daughters were born to the Turners and both are living today.

Dr. Turner was an able and enthusiastic botanist, who had a long list of correspondents across the continent. He was always ready to give assistance where he could and his help to others was by no means the least of his notable contributions to botany. Dr. Turner had a long standing association with *The Ottawa Field-Naturalists' Club* and was made an Honorary Member in April, 1959 in recognition of his contribution to Canadian botany.

Publications of G. H. Turner

Turner, G. H. 1947. Alpine plants in the Pigeon Lake district of Alberta. Canadian Field-Naturalist, 61: 126.

Turner, G. H. 1949. Plants of the Edmonton district of the Province of Alberta. Canadian Field-Naturalist, 63: 1-28.

Turner, G. H. 1949. *Salix petiolaris* in the Edmonton district. Canadian Field-Naturalist, 63: 82-84.

Moss, E. H., and **G. H. Turner.** 1961. Bryophytes from the Edmonton region, Alberta. Canadian Journal of Botany, 39: 1177-1193.

News and Comment

On Peregrine Falcons

Several letters both pro and con have been received from our readers in response to the publication in The Canadian Field-Naturalist (86: 307-309, 1972) of a letter written by Mr. Dick Dekker entitled "The Need for Complete Protection of the Peregrine Falcon". I would like to thank those who have been concerned enough about the issue to write to us. However, as the question of the management of the Peregrine Falcon has become quite an emotional issue, I would ask our readers to form definite opinions only after they have considerably more facts at their disposal. These facts must come from those directly involved in raptor research or from those who have made unbiased evaluations of the research results.

I do not believe that the aims of naturalists, research scientists and falconers are opposed. None of us wants to see the extinction of the birds. Admittedly some falconers have acted in a despicable manner but we must not condemn other falconers for the misdeeds of a few. Most falconers abide by the laws protecting raptors. Indeed, concerned falconers have provided much of our present information on peregrines. Although we are all concerned about the welfare of wild peregrines, it is the method of saving the species from extinction that is in dispute.

The Canadian Wildlife Service believes that there is merit in a controlled captive breeding program for Peregrine Falcons and such a program is under way. So far the researchers have obtained some very encouraging results. I hope that these and other new data on peregrines will be properly documented and published soon. We will all then be in a better position to evaluate objectively the alternatives that are available to us to try to save our Peregrine Falcons.

LORRAINE C. SMITH
Editor

Man and Resources

YOUR resources — food, wealth, energy sources, environment — who decides how they shall be used? There are many problems inherent in the development, distribution, and interactions of resource use. Are you content to leave vital decisions about your future life support systems to a mysterious They? Then here's news: There is NO all-wise, all-powerful They.

There is, however, a body of senior officials of federal and provincial governments responsible for resource policy, who form the Canadian Council of Resource and Environment Ministers (CCREM). They have asked us, the owners and users of resources, to define the problems of most concern to us, to seek solutions and identify alternatives compatible with our social goals. The CCREM is sponsoring a two-year MAN AND RESOURCES program to involve the public in a national dialogue on guidelines for future management of our natural resources.

Last year concerned citizens across Canada formed study groups to identify problems in resource use. From these, 300 delegates met in a National Workshop at Montebello, Quebec, and hammered out a list of the 12 issues of most concern to all Canadians (see below). The CCREM is listening to people as they define the problems, and has promised to consider their solutions.

This year new community groups are forming, each around one (or more) of the 12 issues. Each group will have the benefit of a resource expert in the field chosen. Concurrently the issues will be taken up by Task Forces of recognized national experts, and data will be exchanged between groups of the two levels. Solutions and policy guidelines will be presented in papers at the MAN AND RESOURCES Conference in Toronto, November 4–9, 1973.

Issue-related groups are already engaged in the problem-solving activity, and are hoping to involve more people. This is your opportunity to become part of an exciting participatory government process. If you have ideas, they will be

heard and discussed. If you have not thought through an issue of interest, you can learn a great deal.

ANNE HANES
Ottawa, Ontario

An invitation to all to join Man and Resources program

The aim of Man and Resources is to provide an opportunity for every Canadian to share in the process of deciding how Canada should manage its natural resources and the system of values which should underlie such decisions.

To do this, Canadians from all walks of life are needed — not just those with a claim to expertise — but every individual who is concerned about the future.

To assist you in better understanding the program, we have summarized the issues identified at the recent national workshop held in Montebello, Quebec, as follows:

CITIZEN PARTICIPATION — How to participate at a more meaningful level in the decisions which shape our social and environmental life.

POPULATION — Evaluating the environmental impact of population, per capita consumption, and technological impact per capita.

GROWTH ETHIC — The need to change our attitude from the growth ethic (more is better) to one of living in harmony with the total life system.

DATA — The need to base decisions affecting our natural environment on the conscious application of knowledge of the implications of trade-offs inherent in the decisions.

EDUCATION — To create a national conscience in regard to resources and the environment and, through education, to enable man to live in harmony with his natural and man-created environment.

RESOURCE-PLANNING — Identification and implementation of long-range resource use plans to meet the continuing needs of society.

ENVIRONMENTAL PROTECTION — The need for appropriate measures to protect and restore the quality of the environment reduced through emissions into the air, discharges into the water, contamination of the soil, harmful additions to food and wasting of natural resources.

NORTHERN DEVELOPMENT — The first and highest priority is that the needs of the people be defined and met so that they will be able to contribute to the development of the nation.

DECISION MAKING — The lack of integrated planning and co-ordination in the decision-making process at all levels of government, industry, the public, research organizations, and inter-relationships among all.

FOREIGN OWNERSHIP — The extent and control of foreign ownership in Canada.

OWNERSHIP — A primary issue is land ownership education and the conflict of interests in the use and development of lands.

ENERGY — The need to re-evaluate in terms of long-term goals the provision of energy in all its forms due to the obvious and increasing impact on the environment.

From OUTLOOK '73 December, 1972

If you have not been directly involved with *Man and Resources* and would like more information please direct enquiries to the appropriate Regional Planning Committee.

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Canadian Wildlife Service Scientist Wins International Publication Award

March 1973

Dr. Leslie M. Tuck, a Canadian Wildlife Service biologist and a long-standing member of *The Ottawa Field Naturalists' Club,* has won the terrestrial wildlife publication award of the Wildlife Society for his monograph on the snipes. Dr. Anthony J. Erskine, also a Canadian Wildlife Service scientist, and the present Recording Secretary of *The Ottawa Field Naturalists' Club,* received an honourable mention in the same category for his study of Buffleheads.

Dr. Tuck is the only Canadian scientist to have received the society's publication award twice. The first was given in 1962 for his work on the murres, also published in the Canadian Wildlife Service monograph series. The monograph on the snipes was chosen from nominations by scientists. Dr. Tuck's definitive work is the result of 10 years' extensive research on this nearly globally distributed important game bird.

The Wildlife Society is a leading Wildlife management organization with members in 61 countries. Its Journal of Wildlife Management is considered among the most authoritative in the world. The award is given to encourage excellence in scientific writing on wildlife. The entries were judged by a committee of six scientists, five in the United States and one in Canada. Their main criteria were that the work be on an important wildlife resource; represent original, sound research; contain significant information; and include recommendations of value to management.

Dr. Erskine's monograph is the first to be written on Buffleheads, small diving ducks that nest in trees. Their breeding grounds in British Columbia and Alberta are shrinking as forests are cleared for agriculture, and industrial development and pollution threaten their winter habitat along the seaboards.

Pacific Seabird Group

The Pacific Seabird Group has been formed by the participants in a seabird symposium held at the December 1972 meeting of the Western Society of Naturalists. The aims of the group are to promote and coordinate needed research on marine birds of the Pacific Basin, to make systematic studies of pollution effects upon birds, and to promote a greater awareness of this marine resource. Anyone interested in further information should contact the group's acting secretary, George Divoky, c/o U.S. Fish and Wildlife Service, 1412 Airport Way, Fairbanks, Alaska 99701.

Professor Alan F. Coventry

With the death of Professor Alan F. Coventry, we have lost an outstanding Canadian biologist and field-naturalist whose influence on Canadian biology and biologists has been considerable for several generations. "Covers", as he was called by his many friends and students, was an extraordinarily gifted and enthusiastic teacher, a competent embryologist, an ardent conservationist, and an exceedingly willing educator. In addition he was unconventional enough to be considered eccentric in days when being a non-conformist was not in style. It was in recognition of his many and diverse attributes which had such an impact on his fellow Canadian naturalists that he was made an Honorary Member of *The Ottawa Field-Naturalists' Club* in 1971.

We hope to publish a memorial to him in *The Canadian Field-Naturalist.* Therefore, we would be grateful if anyone with information such as personal reminiscenses, anecdotes etc. that would be useful to include in such a tribute would pass it along to the Editor.

Book Reviews

Botany

Arctic Adaptations in Plants

By D. B. O. Savile. Canada Department of Agriculture, Research Branch, Monograph No. 6. 1972. 81 p. Free on request from Information Division, Canada Department of Agriculture, Ottawa K1A 0C6.

This very readable booklet is difficult to characterize. It is not a comprehensive review, it is not a textbook, it is not a research report. It reads somewhat like a series of well-prepared lectures by an authority in the field of arctic adaptations in plants. Dr. Savile is eminently qualified for the task, and has obviously put his many years of field and laboratory experience to good use by writing this refreshing personal account of a very complicated subject.

The book is divided into five main sections: Introduction (pp. 7–13), Flowering plants (pp. 14–54), Cryptogamic plants except fungi (pp. 55–60), Fungi (pp. 61–75), and Conclusions (pp. 76–77). A selective list of 107 references (21 of which are entirely or partly by Savile himself) concludes the work. A short index might have helped, but a detailed table of contents and numerous cross-references provide a useful alternative.

The technical layout is excellent, verging on flawless. I noticed only a few typographical errors ("Jan Meyen Island" on p. 40, and "asocarp" which occurs three times on p. 62–63). The heading "B Winter survival" placed at the bottom of p. 14 obviously should have been transferred to the top of p. 15, and p. 54 consists of only three lines of text which for some unknown reason were not placed in the ample blank space at the bottom of p. 53.

Dr. Savile's style flows easily, making the booklet a masterpiece of clarity in thought and word. One gets the impression that it has been spared undue editorial interference, and it is consequently more interesting and readable. Far too often original ideas and reflections are made to conform to a more sterile scientific style and format. It is also worth noting that there are only nine simple figures and three tables in the booklet, and any of them could have been omitted without any substantial loss in clarity.

It is significant that the title is *Arctic Adaptations in Plants* rather than *Adaptations in Arctic Plants*. Thus related observations on boreal and montane adaptations are also included. The bulk of the examples used are from the Canadian Arctic but some effort was made to include research from other polar countries.

Not surprisingly the section on flowering plants is the most extensive, especially the discussion on wind dispersal which, although controversial, cannot be ignored by arctic botanists. I noted several minor errors of fact and implication in the section on flowering plants, and especially in the short section on cryptogamic plants except fungi. Perhaps because the author is primarily a mycologist, the section on fungi is probably the best in the book. The elucidation of modifications in life cycles of parasitic arctic fungi is one of its most significant contributions.

Although the quote from Al Purdy's poem "Trees at the Arctic Circle" is welcome, the only aspect of the book which disturbs me is a teleological undertone, e.g. (p. 37) "These are fly-flowers, which have evolved specifically to attract Diptera" and (p. 65) "These fungi have three choices." Undoubtedly biologists are often tempted to use teleology to explain the otherwise unexplainable, but to do so in such a formal way is, I think, unwise. This booklet will be of immense use to students in a wide variety of subjects and it is unfortunate that they may be unconsciously led astray by certain statements in this otherwise excellent treatise.

On the whole, however, arctic botanists must be thankful that the broad topic of arctic adaptations in plants has been handled in such a masterful way. The controversial or weak points of the book in no way detract from the impact the book ought to have, and I feel certain will have, on arctic biology. It is an ideal text for discussion groups or seminars in senior undergraduate or graduate university courses. The Department of Agriculture is to be congratulated in making the booklet available free to anyone on request.

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Alaska Trees and Shrubs

By Leslie A. Viereck and Elbert L. Little. Agriculture Handbook No. 410, Forest Service, United States Department of Agriculture. Washington, D.C. 1972. 265 p. $3.25.

This book represents a considerable improvement over the small 63 page *Pocket Guide to Alaska Trees* (by R. E. Taylor and E. L. Little, 1950) which it replaces. Both trees and shrubs are covered, including subshrubs. Following the introduction is a review of Alaskan vegetation types. Both summer and winter keys to the Alaskan trees and shrubs are included, emphasizing vegetative characteristics for easier identifications. The greater part of the book is devoted to the descriptions of 133 species of trees and shrubs. Key words placed in bold-face type enhance the readability of the descriptions and increase their usefulness for identification purposes. Comments on economic value and on native or pioneer usage of the plants enliven the descriptions. Line drawings, often shaded, and general Alaskan distribution maps are included for most species. The format is made convenient for the reader with the placement of the species descriptions, range maps, and illustrations all on the same page. A valuable contribution is the new, folded, colored vegetation map of Alaska compiled from various previous maps and the author's own field experience.

The book attains a high level of scholarship and production, The taxonomy is of high standard, although one may not necessarily agree with the author's dispensations of such groups as *Salix, Betula,* and *Alnus.* The book is highly recommended to anyone interested in the woody flora of Alaska or adjacent northwestern Canada. It is well worth the modest price.

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Rocky Mountain Flora

By William A. Weber. Colorado Associated University Press, Boulder, Colo. 1972. 438 p. $7.95.

This is the fourth edition of a book, which in the first two editions published in 1953 and 1961, was called "Handbook of Plants of the Colorado Front Range." The 1967 edition, which embodied many changes, was reviewed in this Journal by D. B. O. Savile (1968, Canadian Field-Naturalist 82: 61).

The main body of the text of the present edition does not appear to have been changed from that of the third edition. There are however several great improvements: the text is printed on a thinner, glossy paper, the pages are ¾ inch shorter and ½ inch narrower although the printed area is still the same size, and the cover is slightly thinner and thus more pliable. Even the addition of eight pages of colored plates following page 20 has still left this new edition a full 8 ounces lighter than the third edition. It can thus be more readily packed in the field than its predecessor.

This flora is indeed an excursion flora, which is designed for the use of the advanced amateur. The nomenclature appears to be up to date, so it can serve as a ready reference for the professional botanist as well. The text is in the form of an expanded key. Of the 1575 species treated, approximately one quarter are illustrated by line drawings which were contributed by Dr. Charles F. Yokum.

Rocky Mountain Flora is highly recommended for use in, and adjacent to, the Front Range in Colorado, for which it was intended, but not as the title suggests, for the whole of the Rocky Mountain chain.

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ZOOLOGY

The Age of Mammals

By Björn Kurtén. Weidenfeld and Nicolson, London. 1971. 250 p. The World Naturalist Series. About $9.00.

I have often admired the clarity with which Scandinavian scientists write in English. This is one of the strong points of Kurtén's book. It is clear, readable, and highly informative to both specialists and laymen. Kurtén's reasonable and up-to-date summary of the origins of man is particularly interesting. A rarity in a book of this nature is the author's refreshingly direct discussion of man's responsibility for maintaining the quality of his environment, and his thoughts on the future of man.

In 1910, the well-known paleontologist Henry Fairfield Osborn published an important book "The Age of Mammals in Europe, Asia and North America." It is Kurtén's goal to revise, update, and simplify that rather technical account. Also, he wants to impress us with the responsibility we have for this earth of ours, which has supported such an abundance of life during ages longer than we can comprehend.

Following an initial chapter on the nature of fossils and the origin of mammals, the author succinctly describes the mammalian fauna, flora, and major geographic features of the continents during each of the Cenozoic epochs from Paleocene to Pleistocene — a period which covers the last 65 million years. Kurtén recognizes the Paleocene as a time of mammalian conquest of the land after extinction of the dinosaurs, the Eocene as a period of consolidation, the Oligocene as an epoch of transition, and the Miocene as a long period dominated by change — the uplift of mountain ranges and vanishing of the extensive Tethys Sea. The Pliocene he regards as ". . . something of a paradise lost, a climax of the Age of Mammals before the coming of the cold; a time when life was richer, more exuberant than ever before or after."

Two interpolated chapters provide a description of the peculiar mammalian faunas which arose in Australia and South America — two chips of the former supercontinent of Gondwanaland which remained isolated for most of the Age of Mammals. Here, one is continually reminded that the earth's environmental niches have acted as molds into which the genetically plastic fluid of life has been poured many times at different stages. For instance, *Thylacosmilus* a marsupial of the South American Pliocene shows an amazing resemblance to the more advanced sabretooth cats.

Twenty-eight pages are devoted to a discussion of the Pleistocene. Kurtén thinks that Milankovitch's hypothesis is the best available explanation of the peculiar cold–warm oscillations of the Pleistocene. This hypothesis stresses that perturbations of the earth's movement around the sun have a variable effect on the distribution of solar radiation received by the earth, producing alternately cool summers and cold winters, which would reduce melting and promote growth of inland ice, and hot summers and mild winters, which would increase melting leading to interglacial conditions. The author has no hesitation in saying that we are presently in an interglacial and ". . . on our way towards a new glaciation." An otherwise excellent paragraph describing radiocarbon dating is flawed because it is not stated that C^{14} in an organism decays at a steady, known rate after its death; and there is no mention of the half-life of that isotope. Kurtén demonstrates very effectively the frequency of giant forms among most orders of larger ice age mammals, and among the rodents, remarks on the giant beaver, which was almost as large as a black bear. Conversely, he shows that a great many mammals evolving in oceanic islands were dwarfed. This trend led to the development of the extraordinary Maltese 'donkey elephant' which in adulthood was 3 feet high at the shoulder.

Most of man's evolution has occurred during the last 3 million years, comprising the Pleistocene. In a final chapter on man, the author strongly supports Paul Martin's hypothesis of human "overkill" to explain the great extinction among large ice age mammals, which occurred about 10,000 years ago in North America. He lays stress on human burning of the landscape as a factor in destroying the ice-age megafauna. However, to my knowledge, evidence supporting this idea is poor, or has not been well marshalled. The last few pages on man's future are deeply considered, and cannot be effectively summarized. Read them.

The book concludes with appendices listing orders of four-limbed vertebrates, their common names and approximate spans of existence during the Cenozoic, and providing suggestions for background reading on each of the chapters. Detailed

references are given for 140 pertinent books and papers. There are also short indices to authors, stratigraphic and locality names, and Latin names of species mentioned in the text.

Illustrations are an important part of this book. Simple maps display the approximate distribution of land and sea at various times during the last 65 million years. Most of Margaret Lambert's figures depicting restorations of extinct mammals are diagrammatic and rather uninspired, but this does not apply to her beautiful work in Plate 5 showing *Desmostylus* (a plant-eating, amphibious mammal) retreating from the territory of the large "sea-elephant" *Allodesmus*. A good deal of speculation is involved in making restorations of extinct vertebrates, because of the generally fragmentary nature of their remains. I think Kurtén's restoration of the scimitar cat, with cat-like forelimbs and bear-like hind limbs is highly controversial. However, in another case where controversy exists as to whether the "marsupial lion" *Thylacoleo* was a harmless fruit-eater or a bloodthirsty carnivore, Kurtén has confronted the problem directly by showing both versions!

I recommend this book to anyone interested in biology or the earth sciences because of its finely integrated perspective on mammalian history. Anthropologists should read it because it relates man so well to his fellow mammals. It gives us our bearings in the animal kingdom.

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Parasitic Insects

By R. R. Askew. American Elsevier Publishing Company Inc., New York. 1971. 316 p. $11.50.

Askew presents a discussion of the parasitic form of insects, their ecology, and their evolution. Parasitism is defined in the broad sense as the relationship between two species, in which the species designated as parasitic obtains its nutritional requirements from the body of the host species. The author supports his general theories and conclusions with examples from the literature on world fauna up to 1969.

In the first section of the book, insects which are parasitic as adults are considered. A chapter on mouthparts reviews various modifications for parasitism of the basic insect structures. In "Lice", biting and sucking forms are combined in an aggregate which might be clearer had more headings been used. Fleas, blood-sucking flies, and Diptera Pupipara are presented in separate chapters. These are well done except that some species which are included fit the titles only in the broadest sense. "Bugs, earwigs, beetles, and moths" contains the few species in these Orders which are parasitic as adults. The author completes this section with a short chapter dealing with blood-sucking insects as vectors of human disease.

Section II of *Parasitic Insects* presents insects which are 'parasitic' as immature forms. "Hymenoptera" comprises nearly half of the section. This Order contains the largest number of 'parasitic' species and the author has specialized in the study of the Chalcidoidea (Hymenoptera). Diptera form the next largest group. A separate chapter is inserted to discuss Dipteran larvae which cause myasis in vertebrates. Neuroptera, Lepidoptera, and Coleoptera are combined in one chapter and another contains a full discussion of the Strepsiptera. Askew promotes the utilization of insect 'parasites' in his chapter, "Biological control of insect pests". The continuum of behavior patterns, from free-living types related to 'parasitic' species to true parasites in the strictest sense, is illustrated and discussed in "Commensalism, inquilinism, and social parasitism". General remarks are continued in the final chapter and some examples of parasitism in the Crustacea are added for comparison. A bibliography of literature available to 1969 and cited in the text completes the book.

Although it may occasionally grate on some editorial nerves, this text should be of value to students of entomology and to those studying related host species. The book is well illustrated and presents information not previously available in one place.

Parasitic Insects is a welcome companion volume to Clausen's *Entomophagus Insects* and a useful source of entomological information for those in medical and veterinary research.

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The Life of Mammals, Volume I

By L. Harrison Matthews. Weidenfeld and Nicolson, London W.1. 1969. 340 p. $10.00.

Dr. Harrison Matthews has written a comprehensive volume for the general reader on a wide variety of topics in mammalogy. He begins with a discussion of the evolution of mammals from synapsid reptiles in the Mesozoic era, and in chapter 2 considers the fundamental differences in structure and function that distinguish the mammals from other vertebrates. Classification is next, with a review of all extinct and living orders. The three chapters that follow deal with mammalian adaptations to different environments. Terrestrial mammals are considered first. Locomotion receives a great deal of attention in this chapter, although fossorial mammals and adaptations for coping with temperature extremes and water scarcity are not forgotten. Arboreal and aerial adaptations, with climbing and gliding found in several mammalian orders and powered flight only in the bats, come next. Echolocation of bats, an adaptation associated with nocturnal flight and capture of small prey on the wing, takes up more than half of the chapter. Mammals that have adopted an aquatic way of life, ranging from little-changed semi-aquatic forms to the completely aquatic and specialized seacows and whales are discussed last.

From the substrate and medium that have moulded the animal, attention shifts in chapter 8 to the part of the animal in direct contact with the outside, the skin and structures derived from it. Reception, transmission and processing of stimuli from the outside are discussed in the next chapter which in turn leads to a chapter on behavior.

Reproduction, its physiology and associated behavior, populations, migration and hibernation are subjects discussed in chapters 11 to 13. The last chapter explores the relationship of mammals to man. Contact with man has led to domestication, direct competition, over-exploitation, and in some cases extermination. Burgeoning human populations are the most serious threat to the world's faunas. The basic remedy, Matthews suggests, is to reduce the human population. The choice of whether this will happen by peaceful or violent means is man's.

In a book of this scope, it is not surprising to find a few errors and omissions. Misspelled scientific names occur rather more frequently than one would expect. A few examples are *Phascolarctus,* p. 105 (= *Phascolarctos*); *Neobaleena,* p. 141 (= *Neobalaena*); *Potomogale* (= *Potamogale*); *Didelphys,* p. 248 (= *Didelphis*); *Megapter,* p. 292 (= *Megaptera*). On page 92, the muskrat is erroneously referred to as *Myocastor.*

The book is generally well documented and has a bibliography of 171 titles. In a few instances information is presented that cannot be considered valid in view of available evidence. For example the statement on page 97 that relates yarding of moose to protection from wolves would not be accepted by people who have studied these species in the field or are familiar with the recent literature. Elsewhere on page 288, Seton's claim that bison were migratory, following ". . . more or less circular clockwise paths . . ." is presented as being no longer doubtful. Apparently Matthews was not aware of Roe's (1951, The North American Buffalo) refutation of that claim.

Having said that, I hasten to say that in my estimation Dr. Matthews' book presents one of the best and most up-to-date general accounts of the Class Mammalia for the reader interested in natural history.

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A Field Guide to the Insects of America North of Mexico

By Donald J. Borror and Richard E. White. The Peterson Field Guide Series No. 19. Houghton Mifflin Company, Boston. xi + 404 pp; 1300 illus., inc. 142 in color. 1970. Hardcover, $6.95.

This most recent addition to The Peterson Field Guide Series is an excellent, profusely illustrated and authoritative handbook on North American insects. The method used first in the bird guides by which arrows point out diagnostic features in illustrations is also used here. The shaded or line drawings are conveniently placed near the pertinent text and the characters picked out by arrows are further emphasized by use of italics in the text. Because insects far outnumber birds in total species, no attempt is made to permit keying out

to individual species. In most cases, the general features of the family or subfamily only are defined. Widely known pests or very common insects, such as the European corn borer or the two-spotted lady beetle, are cited by scientific name. In a mid-section of 16 beautiful colored plates, every insect represented is identified by scientific name, common name if such exists and geographic distribution. Most of the illustrations have length lines to indicate the actual size of a specimen; those without lines are described in the text.

The introductory chapters give general information on collecting and preserving insects, working with living insects, the structure, growth and development of insects and how to use the field guide.

The senior author, Dr. Donald J. Borror of Ohio State University, is an authority on dragonflies and insect songs. He is co-author with Dr. Dwight M. DeLong of a widely used textbook, *An Introduction to the Study of Insects*. Dr. Richard E. White of the United States National Museum, is a specialist in beetles and a gifted entomological artist. He painted the color plates and drew the majority of the drawings.

This is the best and most up-to-date general insect handbook available. It should be welcomed by naturalists and entomologists alike as a valuable adjunct to any field trip.

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Palaeozic Fishes

By J. A. Moy-Thomas. Second Edition extensively revised by R. S. Miles. W. B. Saunders Co., Philadelphia, Toronto. 1971. 259 pp. $13.15.

Fishes were the first vertebrates to appear, and they undoubtedly always have been the most abundant and diversified of the vertebrates. Even today there are more species of fish known than of all other vertebrates put together. Furthermore, there are probably more undiscovered species of fish than any other kind of vertebrate. Thus an understanding of the relationships of any contemporary assemblage of fishes is a major problem in itself. Of course a set of biological relationships cannot be understood "by itself." There is always a historical (evolutionary) component that must be taken into account. Here the palaeontologist makes his presence felt. The Palaeozoic Period is that period when fish first appear in the fossil record. Therefore, the book under review is concerned with the origin of fishes and by extension, the remainder of the vertebrates. There are mysteries here difficult to unravel. Owing to paucity of specimens, inadequacies of preservation, and divergences of interpretation, contentious issues have arisen at most points of major evolutionary significance, e.g., the origin of vertebrates and the phyletic relationships of jawless and jawed fish; the phyletic relationships of lampreys and hagfish; the place of acanthodians; the affinities of rhipidistians, precursors to terrestrial vertebrates, and so on.

The book is stated to be the "Second Edition extensively revised by R. S. Miles." Effectively, this means it is Roger Miles' book. The First Edition was published in 1939 by the late J. A. Moy-Thomas. His book, which has been virtually unobtainable for 20 years, provided the best single introduction to studies of fish of the Palaeozoic. However, and here I am practically paraphrasing the dustcover of the book, a postwar upsurge in interest with new discoveries, new techniques, and new syntheses, has rendered much of the old interpretation obsolete. "It became necessary to revise the contents."

In the revision of *Palaeozoic Fishes* Miles has succeeded in providing a summary of current knowledge of, and opinion on the subject. He provides an eclectic, but uniform classification of early fishes; one could quarrel with parts of it, but it is internally consistent, is not unorthodox, and will provide a secure introductory basis for understanding the relationships of fishes. Dr. Miles smooths the sharp edges of disagreement at most places of contention; he always takes a stand, which he argues reasonably. The differences of opinion can be explored, if the references provided are consulted, but without care the reader will not be aware of the depth of disagreement that sometimes exists. Miles points out, as Jarvik of Stockholm has for years, that "all the fossil and living fishes that are known fall readily into one of these [main] subdivisions, for in no case have convincing intermediate forms been described," which effectively halts attempts to draw elegant diagrams of phylogenetic relationships.

The book is to be praised for its effort to include some ecological comments about the fish discussed. Vertebrate palaeoecology is not a very advanced subject, but any efforts in that direction do put flesh on the dry bones. Here too, it becomes apparent, though not overtly stated, that convergence in the evolution of form may be seen to a marked degree among all the major subdivisions of fishes. In Miles' presentation the last vestiges of transcendental (archetypal) anatomy are replaced by pragmatic morphology. What was known as the "Head Problem" is not raised. Gill slits and other branchiomeric and myomeric structures are interpreted for what they are, not what they might be desirably.

There are comments to be made about the technical organization of the book. I think the systematic organization is excellent, as well as the summary classifications starting each chapter, and the thorough and up-to-date references at the end. The index comprises only the names of fishes and authors. I think this is sufficient, for this book does not attempt to be exhaustive on matters such as the parasphenoid or the hyomandibula or any other structure. It is to be read as a survey of present knowledge, not as a treatise of morphology. The figures, many and well-done, are made uniform each having been redrawn after its source. Each has a metric scale included. A certain amount of simplification results, and sometimes structures remain mysterious, being drawn in detail, but unlabeled (eg., Figure 4.13), and in one instance labeled with an enigmatic "X" (e.g., Figure 1.2; I can guess at the meaning, but should I have to?). Nonetheless, the illustrations are very successful. The text has many cross references to other sections; this is useful to keep concepts or relationships together in the reader's mind.

The copy of *Palaeozoic Fishes* that I have has an Errata list on the end-paper. There were five errata shown, the most serious being the repetition of a line of classification with the loss of another line. In my reading I came upon another seven or eight typographical errors, which I think it too many for a book of this size and scientific quality.

The book is a success. It will be required reading for any serious introductory course in Vertebrate Palaeontology and will be a useful reference book for all vertebrate palaeontologists. We can hope that its revision will follow before another 30 years has passed. Maybe too, it will give impetus to the production of the mooted book on Mesozoic fishes.

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Birds of Moose Mountain, Saskatchewan

By Robert W. Nero and M. Ross Lein. Saskatchewan Natural History Society, Special Publication No. 7. 1971. 55 p., 8 figs., 2 maps. $2.00

Although rising little more than 500 feet above the surrounding plains, Moose Mountain is an oasis of dense deciduous forest and clear lakes in the broad grasslands of southeastern Saskatchewan. Thus it provides an intriguing 'island' of breeding habitat for a variety of woodland birds.

The authors have brought together all known data on the birds of the area gathered by others, going back to John Macoun in 1880, and have combined them with the observations made by an ornithological survey party composed of the junior author, Richard M. Sanderson, and Spencer G. Sealy in the period May 4 to June 19, 1965.

The well-documented annotated list covers 173 species of birds that have been recorded within Moose Mountain National Park's 150 square miles. Nesting data are given where available and these extend the known breeding range of a number of species including Ring-necked Duck, Common Goldeneye, Bufflehead, Cooper's Hawk, Broad-winged Hawk, Virginia Rail, Yellow-bellied Sapsucker, Eastern Phoebe, White-breasted Nuthatch, Myrtle Warbler, Northern Waterthrush, American Redstart, Rose-breasted Grosbeak, Purple Finch, and White-throated Sparrow. The evidence suggests breeding range extensions also for the Orange-crowned and Mourning Warblers and the Ovenbird, but more definite information is needed. Some of the range extensions are slight, others involve considerable distances. Eight photographs and two range maps illustrate this useful report.

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Guide to Identification of Marine and Estuarine Invertebrates: Cape Hatteras to the Bay of Fundy

By Kenneth L. Gosner. Wiley-Interscience, New York, London, Sydney, and Toronto. 1971. xix + 693 p., illus. $29.50.

This book intends to provide readers with a single comprehensive guide to the identification of invertebrate animals of the east coast of the United States north of Cape Hatteras. The first three introductory chapters give a background of the physical and biological environment of the area and a systematic introduction. Each of the invertebrate phyla (Protozoa omitted) is treated in the succeeding 21 chapters, each following a similar format composed of a *diagnosis,* a *general descriptive section,* a *systematic list and distribution,* an *identification* with supplemental keys, tables and figures, and a list of *references.* There are two indices concluding the book, a general index of biological terms and systematic names above generic level and a systematic index of generic and species names.

Some errors are bound to exist in a comprehensive book such as this. The author is mistaken, for instance, in stating that members of Ctenophora and Chaetognatha are exclusively planktonic. Despite his precaution of having all chapters reviewed by many authorities in different fields of invertebrate zoology, there are still some invalid names included in his systematic list. One special case is the list of Amphipoda (Crustacea): three out of 11 species of the suborder Hyperiidea are invalid. The range of body size is sometimes important for quick identification in Copepoda, but the range given for *Calanus finmarchicus* apparently covers this and a larger congener *C. hyperboreus,* also found in the area north of Cape Cod. Most figures supplementing the keys are only of parts of the body or appendages which characterize the species. Generally these figures serve the purpose of identification, but certain improvements should be made if the book is revised. Almost all illustrations are too small, and some are so small that they hardly have any significant function (especially those of polychaetes and copepods). The systematic index is well prepared but with some omissions and errors. For example, in Table 21.6, the names of three authors of species are in error, and there is an omission of one species.

Despite a few shortcomings, such as those pointed out above, this book is highly recommended for amateur biologists and for biological laboratories along the east coast of United States and Canada. It is the only comprehensive book available in North America to assist non-specialists in identifying a wide spectrum of invertebrate animals found in the rich coastal and estuarine waters. With corrections and improvement in future revisions, it will become, for North American students, a standard manual for marine biology comparable to the well known *Ward and Whipple's Freshwater Biology.* The author's decision to tackle such a work must be admired by all readers. Without his courageous decision, we might not have a book of this type available for several decades.

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The Fishes of Zanzibar: Acanthopterygii and Pharyngognathi, etc.

By R. Lambert Playfair and Albert C. L. G. Gunther. With a new introduction by George Sprague Myers and a new forward by A. E. Gunther. Newton K. Gregg, Publishers, Kentfield, California. Hand-colored Reprint Series Number 1. $99.50.

This book has long been rarely available to students of ichthyology and its reappearance is especially welcome. Six plates are hand-water-colored, as were the originals. The text is a photo-offset facsimile of the original.

Included are a new forward by the grandson of the junior author, and an especially valuable new introduction by G. S. Myers. This latter provides a summary of early ichthyological research and monographs not dealing with European fishes, and a much-needed history of the last centuries' ichthyological illustration.

The present edition is limited to 350 copies.

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The Wasps

By Howard E. Evans and Mary Jane West Eberhard The University of Michigan Press, Ann Arbor, Michigan; Longmans Canada Limited, Don Mills, Ontario. 1970. 265 p. $7.75 cloth, $3.45 paper.

Insects of the order Hymenoptera display some of the most remarkable phenomena to be found in the Animal Kingdom, culminating in the evolution of social systems which are in some ways more specialized than our own. It is therefore, perhaps, logical that they should have caught the interest of some of the best scientists who have ever investigated animal behavior. By a fortunate coincidence, many of these men were also masters of scientific writing, both in the strictly technical and in the semi-popular field. This book is a welcome addition to the second category.

To most people, wasps are either "hornets" or "yellow-jackets", living in aerial or underground paper nests. Some may include "mud-daubers" among their acquaintance. Actually there are thousands of kinds of "solitary" wasps which do not have a communal life, and in which the mothers never see their offspring. Among these are some which show the first signs of social wasp evolution. The first part of this book, after some introductory material, deals with these solitary and sub-social species. Although they lack the complexities of the social wasps, the solitary types shows an almost infinite variety of behavior patterns, some of which *look* as if they were guided by intelligence; for example the *Bembix* which leaves open, false tunnels and carefully covers the tunnel in which it has buried its prey, thus deluding the parasites which try to attack it. A generous sample of these behavior traits is supplied.

Two chapters cover the social wasps, particular attention being given to *Polistes*, the long-legged wasps that make open comb nests in the temperate zone as well as in the tropics. These wasps show very well the evolution of the social habit. Numerous details are given to illustrate the many facets of wasp behavior in all parts of the world. This section includes such items as the origin of the idea of paper made from wood pulp: Reamur, in 1719, after observing the paper nests of wasps, suggested the possible use of this material to replace rag paper. The development of an "insect repellent", aimed against ants, can be credited to wasps. Compare with our "fly dopes!"

The last chapter deals with the very intricate relations among wasp species, and between wasps and their parasites, predators, guests, imitators, etc. As the authors say "In the tropics, aposematic and mimetic patterns centering about social wasps become striking almost to the point of incredibility." Mimicry of wasps occurs not only in coloration but in behavior and even in sound production.

It seems to me that it must be a very lukewarm naturalist who will not be carried away by this book.

The text seems very free of mistakes, the index works, and there is a small simplified glossary which will be useful to the reader who lacks an entomological background.

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ENVIRONMENT

A Citizen's Guide to Air Pollution

By David W. Bates McGill-Queen's University Press, Montreal. 140 p. $2.95 paper, $5.00 cloth.

David Bates is Professor of Experimental Medicine, Chairman of the Department of Physiology at McGill University and a senior physician at the Royal Victoria Hospital in Montreal. Because of his training and experience, he has brought together in this short booklet, a very comprehensive set of reference data on the real effects of air pollutants on persons and materials, the nature of pollutants and their sources. The presentation is unemotional and dispassionate. It is different from some previous publications in the field which have relied on emotion and inuendo to dramatize effects. As handled by Dr. Bates the facts make the cases where there is one to be made.

Commenting on the recent legislative steps taken to reduce the amounts of the pollutants released by motor vehicles, Dr. Bates believes the motor vehicle is still a good flexible means of transport better adapted for long journeys than for short urban trips.

Dr. Bates makes the following points: (1) Man is putting into the earth's atmosphere a wide

variety of pollutants that possess different characteristics and present multiple problems; (2) Careful measure of pollutants in the modern city environment is necessary if control action is to be taken. The increase in urban air pollution over the last 40 years has been due partly to the increased demand for energy, and partly to the expanding use of the automobile for personal transport. Particulate air pollution combined with sulphur dioxide has measurable effects on the materials of which cities are constructed and on the fabrics used by its inhabitants. Adverse effects of air pollution on health are subtle but they have been clearly demonstrated to occur in cities in technologically advanced countries. Health problems created by cigarette consumption far outweigh at present those caused by air pollution. That is no reason to discount the air pollution effects which have been documented. Costs of air pollution are sufficiently high to necessitate a reduction in air pollution levels in most industrial cities. Carbon dioxide, sulphur dioxide, nitrogen oxides, and carbon monoxide do not appear to be long-term problems in the earth's environment, but particles of lead and other metals released in the atmosphere represent potential hazards.

There is a need for the younger generation to be brought up with a new understanding of, and respect for, natural environment. Legislation required to deal with air pollution faces formidable jurisdictional problems. Attempts to deal with pollution in other countries have demonstrated the clumsiness of the decision-making processes in a democratic society. Attempts to involve the public in policy determination in air pollution have been only partly successful. Informed public opinion and a restructured educational system are needed to keep politicians continuously aware of their responsibilities.

The book is carefully produced, well written, and illustrated with four striking color photographs. It is recommended to any person concerned with air pollution problems in Canada.

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Only One Earth — The Care and Maintenance of a Small Planet

By Barbara Ward and René Dubos. Hard cover edition, W. W. Norton 1972 $8.00/304 pp. (Paperback $1.95). Penguin Books. 1972. (not presently available in Canada).

Maurice Strong, in his role as Secretary-General of the United Nations Conference on the Human Environment, commissioned this book as a "report on the human environment" and a "conceptual framework for participants" in the Stockholm Conference of June 1972.

The commissioning phrases have meant many different things to different people. Not a few, like myself, may have anticipated a "state of the ecosystem report". The book is definitely not a definitive reference work on the state of the planetary ecosystem in 1972. That was clearly not the intention. Instead it is a sometimes inspired, sometimes hurried, occasionally stumbling, but overall thoughtful and often poetic essay on human aspirations within that ecosystem and their relationship to its limitations and hazards in the closing decades of the twentieth century.

The book had an unusual gestation. As outlined in Maurice Strong's preface, Barbara Ward and René Dubos prepared the original manuscript. Copies were then sent to slightly more than 150 prominent consultants. These ranged from Glen Seaborg (former Chairman, U.S. Atomic Energy Commission), through lawyers, bankers, economists, the President of Imperial Oil Ltd., anthropologists, geneticists, architects, specialists in international development, and a reasonable sprinkling of respectable ecologists. In the month available about half of these "consultants" responded with criticisms, comments, and contributions. Something of the nature and diversity of this response is recounted in the book's introduction, but its spoor is not readily identified elsewhere in the text.

The text is organized into five parts and 15 chapters. Part I is entitled, "The Planet's Unity". The main thrust is historical, establishing a frame of reference in human terms and tracing technological innovation from its dim beginnings to the present period. Contemporary man is characterized as attempting to substitute a "technosphere" for the biosphere, and living "aspiringly and uncertainly" in the interface. The present is the "hinge of history" in which expansion of numbers and aspirations of men lead to deep contradictions between the open-endedness of human wants, and the finiteness of Earth's capacity to sustain.

The approach is more man-centered than ecosystem-centered. The fundamental interaction is viewed as a relationship between science, market economics, and the emergence of the nation state. While science has provided immense insight into the living and non-living worlds, has demonstrated essential unities, and has unleashed the "promethean fire" of nuclear energy, its advance has not been accompanied by reflection and restraint. While the market system has financed science and technology, and has brought health and security to increasingly higher proportions of mankind in at least some regions, it has accomplished these things at the cost of externalizing such "diseconomies" as pollution. Further, it has failed to provide as effectively as we would like for such public "goods" as urban design, health, education, and general environmental quality. While the nation state has abetted the mobilization of markets and technology, it has left a legacy of distrust, suspicion, and massive armaments' expenditures.

The general direction of corrective responses lies, according to the authors, in identification of the sources of these failures, and movement away from the divisive, separatist, tendencies. In Part II the unities of science, as seen in the one-ness of matter and energy, the unity-and-stability-in-diversity of ecosystems, and the common mechanisms of inheritance and evolution in a vast multitude of species, are offered as the model upon which economic and political unities may be constructed.

Part III turns to what are regarded as "problems of high technology". Chapter headings identify four problem areas: the discontinuity of development, pollution, the use and abuse of space associated with waste disposal, urban growth and the maintenance of natural communities, and the balance of resources.

The theme of unity is carried forward in terms of the growing network of international trade and communication. Socioeconomic imbalances and inequalities are explored, with per capita income of $400 taken as the dividing line between the developed and developing countries. The latter are characterized as sharing acute problems in the areas of rapid population growth, less reliable climate, less competent soils, high unemployment, low literacy, and less well known ecology.

In the examination of the market and social cost of pollution the concentration is on the highly developed technologies, with their maxi-garbage cultures. Similarly, the problems of the center city are viewed primarily from the perspective of temperate and technologically developed areas, and discussion of the balance of resources emphasizes the high rates of consumption in the developed lands.

In the discussion of energy resources caution is emphasized with respect to nuclear energy. Nevertheless, and this is a criticism which I will expand on later in this review, the question of whether it is better to "solve" the energy problem by development of new energy sources, or by management of human populations and their needs, is not squarely faced. The important point is made that with respect to atomic energy (and many another environmental problem) a significant difficulty is that citizens cannot master all of the technical details, the best they can do is apply commonsense to the general approach. The authors' own conclusion is that, given the population, its growth, and its needs, it is better to go the atomic route with care than to look at alternatives. The assumption remains that the costs to the ecosystem which this choice entails can be regarded in some sense as externalities and assumed to be tolerable both to man and to the ecosystem. The ecosystem remains a "free good".

Part IV deals specifically with the developing regions. They are characterized in terms of economics, and in terms of population pressures. It is here that the population issue is faced in the most straightforward manner. Various possibilities as to rates of stabilization are considered. The authors assume that it will only be when governments in the developing lands perceive, for themselves, that population stabilization is desirable or necessary, that outside encouragement will be effective.

Chapter XI is concerned with agricultural and industrial growth. In the area of agriculture it is anticipated that research will produce appropriate technology to extend the "green revolution" throughout the developing world. The economic and social consequences and problems are examined. The problems of industrialization and the strategies for improvement of human settlements are then considered. The emphasis is on strong central planning and control in all aspects of economics and government (not much consideration is given to the cost in individual liberty). The objective is to gain time. This time is to be used to evolve, in the developing world, a "modernized, technological, high-productivity society, based upon stabilized population, high investment and skills". It is emphasized that this

goal requires the cooperation of the *whole* of humanity, and stress is rightly placed on a re-orientation of values in the developed world. For the developing world, growth is still the goal. That the ecosystem and its resources are adequate for that growth is assumed but never substantiated.

Part V is entitled, "a planetary order". The titles of its three chapters are "The Shared Biosphere", "Co-existence in the Technosphere", and "Strategies For Survival". The emphasis in the first of these chapters is on the atmosphere and the oceans, areas where national property rights are less well established and precedents for international cooperation and organization exist. The technosphere chapter examines some of the friction points between the unity of the biosphere and the lack of a matching unity in the technosphere (the difficulties of finance, the dissatisfaction and frustration furthered by improved communications in a world of inequalities, the precariousness of peace). Resource sharing is proposed, but without guidelines for its implementation. The emphasis in the last chapter is on the need for knowledge of ecosystem function, and the need for development of international co-operation in decision-making processes affecting the functioning of the biosphere and the survival of man. "Does not [earth] deserve all the inventiveness and courage and generosity of which we are capable to preserve it from degradation and destruction and by doing so to secure our own survival?"

I have one major criticism. This book, like the conference for which it was prepared, failed to ask the right question. Until we stop asking, "how can we provide for all these people?" and ask instead, "how many people do we want?", our only ecosystem, and man, will remain in growing jeopardy.

Only One Earth is a beautiful book, a loving book. Every environmentalist should read it. While I feel that despite its depth and perceptiveness it fails to confront the population-resource-planetary carrying capacity dilemma squarely, it contains many healthy reminders that clean air, clean water, and abundant wildlife are *not* priority goals for human beings trapped in poverty, starvation and futility. I recommend it enthusiastically, emphatically, perhaps even pleadingly, to everyone who has a continued interest in environmental questions.

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Hormonal and Attractant Pesticide Technology

By Yale L. Meltzer. Noyes Data Corporation, Park Ridge, New Jersey. 1971. 281 pages. $35.00.

As generations of insect pests continue to develop increasing resistance to conventional insecticides, where shall we turn to novel forms of pest management? As we find that increasing numbers of insecticides tend to persist and simultaneously produce undesireable effects on non-target organisms, are there any alternatives? These and other questions are answered in this text concerning the chemistry of "third generation" insecticides.

Meltzer begins with a well-organized chapter (which may be easily understood by non-entomologists) on the need for more selective insecticides, in a summary of the findings of the Mrak Commission of 1969. This, however, may not be appropriate for the more highly technical details which are contained in subsequent chapters.

The major portions of this work deal with juvenile hormones, ecdysone (molting hormone), and insect attractants. With each major type of chemical, the author systematically analyzes the technical details involved in the purification and identification of the natural compounds, and the step-by-step synthesis and confirmatory analysis of the related analogues. Alternative methods of synthesis are also included. Thus, three-dimensional reconstructions of each complicated chemical molecule can be appreciated. The physical-chemical details are particularly well-documented but may be interesting only to research chemists and industrial firms planning to develop these products. The word "technology" in the title of this book is thus truly applicable.

Insect attractants, including sex pheromones, cover a wide variety of researches and the many advantages of using them within current pest control programs are cited. Many of these compounds are so biologically active that very small quantities, such as 0.1 μg, can produce the desired effect. The biological experiments are only briefly covered and, in some cases, the reader is merely referred

back to the scientific literature for further particulars.

In general, the book is well referenced. Unfortunately, some references occur within chapters while others are located at the end of chapters. Another drawback is the lack of a subject index, although an author index is included.

In the concluding chapters, the "Regulation of pesticides in the United States" is covered to some depth and some of the principal patents are reproduced in French and German. Although many efficacy and toxicological questions must yet be answered before these compounds will be commercially available, this treatise indicates that much of the early developmental work has been accomplished and that these highly selective chemicals may soon emerge as potential control agents in the near future.

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Biological Aspects of Thermal Pollution

By Peter A. Krenkel and Frank L. Parker, (Eds.) Vanderbilt University Press, Nashville, Tenn. 1969. 407 p. $7.95.

This is the Proceedings of the United States National Symposium on Thermal Pollution held in 1968. It consists of some 20 formal papers by well-known American aquatic biologists and engineers, together with one British scientist, and a record of the ensuing discussion from the floor. The result is a valuable cross-section of knowledge and opinion concerning the biological problems attendant on the discharge of heated water, chiefly arising from the operation of thermal electric generating stations. There is also a chapter I believe biologists will find useful, in which the engineering aspects of dealing with thermal pollution are outlined and the magnitude of the problem is assessed as it relates to the United States in the near future.

The formal papers are almost uniformly of a high quality and present a useful review of the various aspects of the effects of temperature on organisms both in the laboratory and in the field, mostly by workers with much experience concerning the matters they treat. Thus algae are dealt with by Ruth Patrick, and fish by D. I. Mount. There is an extremely interesting chapter on the effects of the Hanford Atomic Energy establishment on the thermal regime of that section of the Columbia River, which partly raises the veil on what has been to most of us a mysterious operation. As with most mysteries the reality is not so bad. Balance to the treatment of the subject by the research agency engaged by the Atomic Energy agency is given by a counter discussion presented by a worker from the then U.S. Bureau of Commercial Fisheries engaged in a parallel investigation, and then finally these two somewhat opposing views are clarified by discussion from the floor. Such balanced treatment is typical of the whole book.

While the book is a valuable summary of knowledge and practice in its time, that value does not lie so much in a record of accomplishment as in the demonstration of the danger and the need for a more determined and enlightened search for assessments and solutions. We don't really know yet to what extent there is a problem, much less how to offer a solution to it.

Alabaster, the British scientist, has given a compact review of the impact of thermal generating stations on British rivers.

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NEW TITLES

Botany

Banks, Harlan P. 1972. **Evolution and Plants of the Past.** The Macmillan Press Ltd., London and Basingstoke, 170 p. £1.60.

Birks, H. J. B., and R. G. West [Eds.]. 1973. **Quaternary Plant Ecology.** Blackwell Scientific Publications, Oxford, London. 300 p. £5.00.

Gimingham, C. H. 1972. **Ecology of Heathlands.** Chapman and Hall, London. 266 p. £4.75.

Kirk, D. R. 1970. **Wild Edible Plants of the Western United States (Including Also Most of Southwestern Canada and Northwestern Mexico.** Naturegraph Publishers, Healdsburg, Calif.

Li, Hui-lin. 1972. **Trees of Pennsylvania the Atlantic States and the Lake States.** Univ. Pennsylvania Press, Philadelphia, Pa. 276 p. $17.50.

Rorison, I. H. 1969. **Ecological Aspects of the Mineral Nutrition of Plants.** Blackwell Scientific Publications, Oxford, London. 506 p. £5.00.

Valentine, D. H. [Ed.]. 1972. **Taxonomy, Phytogeography and Evolution.** Academic Press Inc., New York and London. 431 p. £7.20.

Van Der Pijl, L. 1972. **Principles of Dispersal in Higher Plants.** 2nd ed. Springer-Verlag, New York. 162 p. $12.00.

Zoology

Anon. 1972. **The Marvels of Animal Behaviour.** National Geographic Society. 422 p. $11.95.

Axelrod, H. R., and W. E. Burgess. 1972. **Pacific Marine Fishes.** Tropical Fish Hobbyist Pub. Co., New York. $23.00. Avaliable Clarke Irwin Co., Toronto.

Barbosa, P., and T. M. Peters. 1972. **Readings in Entomology.** W. B. Saunders Co., Philadelphia, Pa. 450 p. $6.50.

Blanc, M., P. Banarescu, J.-L. Gaudet, and J.-C. Hureau. 1971. **European Inland Water Fish: A Multilingual Catalogue.** Fishing News (Books) Ltd., London. £8.75. Published for the FAO. 393 species mentioned with range maps for each.

Burton, J. 1972. **Animals of the African Year: The Ecology of East Africa.** Peter Lowe Co., London. 173 p. £2.95.

Bruemmer, F. 1972. **Encounters With Arctic Animals.** American Heritage Press, New York. 254 p. $14.95. Spectacularly illustrated record of living in the Arctic wilderness among seabird colonies, seals polar bears etc. Shows how the animals live, hunt and sustain the Eskimos.

Edwards, C. A., and J. R. Lofty. 1972. **Biology of the Earthworms.** Chapman and Hall, London. 296 p. £3.25.

Eltringham, S. K. 1972. **Life in Mud and Sand.** Crane-Russak Co. 218 p. $9.75. Demonstrates the underlying principles governing mud flats.

Fleay, D. 1972. **Nightwatchmen of Bush and Plain: Australian Owls and Owl-like Birds.** Taplinger Pub. Co., New York. 163 p. $8.50.

Fryer, G., and T. D. Iles. 1972. **The Cichlid Fishes of the Great Lakes of Africa: Their Biology and Evolution.** Oliver and Boyd, Edinburgh. 641 p. £12.00.

Greenberg, I. 1972. **The Living Reef.** Seahawk Press, Miami. 110 p. $5.95. Corals and fishes of Florida, the Bahamas, Bermuda and the Caribbean.

Henny, C. J. 1972. **An Analysis of the Population Dynamics of Selected Avian Species: With Special References to Changes During the Modern Pesticide Era.** Wildlife Research Report No. 1, U.S. Bureau Sport Fisheries and Wildlife. 99 p. $1.00. Available Superintendent of Documents, U.S. Government Printing Bureau, Washington, D.C.

*Keast, A., F. C. Erk, and B. Glass [Eds.]. 1972. **Evolution, Mammals and Southern Continents.** State University of New York Press, Albany. 543 p. $17.50.

Maitland, P. S. 1972. **A Key to the Freshwater Fishes of the British Isles with Notes on their Distribution and Ecology.** U.K. Freshwater Biological Association Scientific Publication No. 27. 139 p.

Manning, Aubrey. 1972. **An Introduction to Animal Behaviour.** 2nd ed. Macmillan Co. of Canada Ltd., Toronto. 294 p. $6.75.

Naumov, N. P. 1972. **The Ecology of Animals.** Univ. Illinois Press, Urbana. 650 p. $17.50. Translated from 1963 Russian edition.

Nixon, M. 1972. **The Oxford Book of Vertebrates. Cyclostomes, Fish, Amphibians, Reptiles and Mammals.** Derek Whitely, London; Oxford University Press, New York. 216 p. $14.95.

Miller, D. J., and R. N. Lea. 1972. **Guide to the Coastal Marine Fishes of California.** Calif. Dept. Fish and Game Bulletin 157. 235 p. Available from Office of Procurement, Documents Section, P.O. Box 20191, Sacramento, Calif. 95820.

Orr, R. T. 1972. **Marine Mammals of California.** University of California Press, Berkeley. 65 p. $1.95. California Natural History Guides No. 29.

Payne, R. 1973. **Behaviour, Mimetic Songs and Song Dialects, and Relationships of the Parasitic Indigobirds *(Vidua)* of Africa.** American Ornithologists' Union Ornithological Monographs No. 11. 333 p. $8.00.

Rorabacher, J. A. 1970. **The American Buffalo in Transition.** North Star Press, Saint Cloud, Minn. 146 p. $6.50.

Ryden, Hope. 1972. **Wild Horses.** Secker and Warburg Ltd., London. 111 p. £3.75.

Savory, T. H. 1971. **Evolution in the Arachnida.** Merrow Pub. Co. Ltd., Watford, U.K. Available from Bonn Industries, Plainfield, N.J. 42 p. $4.00.

Sawyer, R. T. 1972. **North American Freshwater Leeches, Exclusive of the Piscicolidae, With a Key to All Species.** Univ. Illinois Press, Urbana. 154 p. $8.50.

†Schaller, G. B. 1972. **The Serengeti Lion.** Univ. Chicago Press, Chicago. 480 p. $12.50.

Scott, P. 1972. **The Swans.** Houghton-Mifflin Co., Boston. 242 p. $15.00.

Seed, A. 1972. **Sea Otter in Eastern North Pacific Waters.** Pacific Search Books, Seattle, Washington. 38 p. $1.50.

Stebbins, R. C. 1972. **Amphibians and Reptiles of California.** Univ. California Press, Berkeley, Calif. 152 p. $2.75. California Natural History Guides No. 31.

Sweeney, J. B. 1972. **A Pictorial Mistory of Sea Monsters and Other Dangerous Marine Life.** Crown Publishers, New York. 314 p. $9.95.

*Vaughan, T. A. 1972. **Mammalogy.** W. B. Saunders Co., Philadelphia, Toronto. 463 p. $14.95.

Whitehead, G. K. 1972. **Deer of the World.** Constable, London. 208 p. £5.00.

Winn, H. E., and B. L. Ollo [Eds.]. **Behaviour of Marine Animals.** Plenum Press, New York. Vol. 1 Invertebrates, 244 p. $16.00; Vol. 2 Vertebrates, 503 p. $16.00.

Worth, C. B. 1972. **Of Mosquitoes, Moths, and Mice.** W. W. Norton, New York. 258 p. $8.95.

*Wrigley, R. E. 1972. **Systematics and Biology of the Woodland Jumping Mouse, *Napeozapus insignis*.** Illinois Biological Monographs No. 47. 117 p. $7.95. University of Illinois Press, Urbana.

Wylie, S. R., and S. Furlong. 1972. **Key to North American Waterfowl.** Livingston Pub. Co., Wynnewood, Pa. 32 p. $3.95.

Vernberg, W. B., and F. J. Vernberg. 1972. **Environmental Physiology of Marine Animals.** Springer-Verlag New York. 346 p. $19.80.

†Von Frisch, Karl. 1972. **Bees, Their Vision, Chemical Senses, and Language.** rev. ed. Cornell Univ. Press, Ithaca, N.Y. 157 p. $2.45.

Environment

*Ayres, R. V., and R. P. McKenna. 1972. **Alternatives to the Internal Combustion Engine: Impacts on Environmental Quality.** Johns Hopkins University Press, Baltimore, Md. 324 p. $12.00. Published for Resources for the Future Inc.

Cox, P. R., and J. Peel [Eds.]. **Population and Pollution.** Academic Press Inc., New York and London. 163 p. $7.50.

Dorfman, R., and N. S. Dorfman [Eds.]. **Economics of the Environment: Selected Readings.** W. W. Norton Co., New York. 426 p. $10.00.

Edde, W. H., G. S. Leon, and R. C. Milne. 1972. **Consider the Process of Living.** The Conservation Foundation, Washington, D.C. 130 p. $5.95.

Gillette, Elizabeth [Ed.]. 1973. **Action for Wilderness.** A Sierra Club Battlebook. $2.25. Available Clarke Irwin Co., Toronto. From the 12th Biennial Wilderness Conference comes a provocative collection of practical guidelines for identifying wildland resources.

Goldsmith, E. *et al.* [Eds.]. 1972. **Blueprint for Survival.** Houghton-Mifflin, Boston. 189 p. $4.95.

Jerome, J. 1972. **The Death of the Automobile.** W. W. Norton, New York. 288 p. $6.95.

Kevaler, Lucy. 1973. **Noise: The New Menace.** Sierra Club. $5.95. Available Clarke Irwin Co., Toronto. The form of pollution that has received the least attention is examined for its impact on man.

Le Cam, L. M., J. Neyman, E. L. Scott [Eds.]. 1972. **Effects of Pollution on Health.** Proc. 6th Berkeley Symposium on Mathematical Statistics and Probability. Univ. Calif. Press, Berkeley. Vol. 6. 599 p. $22.50.

Ranwell, D. S. 1972. **Ecology of Salt Marshes and Sand Dunes.** Chapman and Hall Inc., London. 200 p. £4.60.

Schoenfeld, C. [Ed.]. 1973. **Interpreting Environmental Issues: Research and Development in Conservation Communications.** Dembar Educational Research Services Inc., Box 1148, Madison, Wis. 53701. 308 p. $9.90. Selected papers from the Journal of Environmental Education.

Schurr, Sam H. [Ed.]. 1972. **Energy, Economic Growth, Growth and the Environment.** Johns Hopkins University Press, Baltimore, Md. 232 p. $10.00. Published for Resources For the Future Inc. Examines, from different points of view, two societal objectives of importance: providing energy to meet the needs of economic growth and protecting the quality of the natural environment.

Sierra Club Editors. 1973. **How to Walk Softly in the Wilderness.** A Sierra Club Totebook. $2.95. Available Clarke Irwin Co., Toronto. How to enjoy the wilderness without wrecking it — a practical book filled with tips on minimizing your own impact on the out-of-doors.

Strobbe, M. A. 1972. **Environmental Science Laboratory Manual.** C. V. Mosby Co., St. Louis, Mo. 138 p. $4.95.

Thomas, W. A. [Ed.]. 1972. **Indicators of Environmental Quality.** Plenum Press, New York. 275 p. $21.00. Proceedings of an AAAS Symposium, Philadelphia, Pa., Dec. 1971. Environmental Science Research Vol. 1.

Wayburn, Peggy. 1973. **Edge of Life: The World of the Estuary.** A Sierra Club Landform Book. $14.95. Available Clarke Irwin Co., Toronto. Life on this earth evolved from the brackish estuaries and yet man continues in an effort to convert them into garbage dumps and estuaries.

Canadian

†Barr, D. 1972. **The Ejaculatory Complex in Water Mites (Acari: Parasitogengona): Morphology and Potential Value for Systematics.** Life Sciences Contribution No. 81, Royal Ontario Museum, Toronto. 87 p. $5.50.

†Campbell, R. W., M. G. Shepard, and W. C. Weber. 1972. **Vancouver Birds in 1971.** Vancouver Natural History Society, Box 3021, Vancouver 3, B.C. 88 p. $1.50.

Connors, I. L. 1972. **Plant Pathology in Canada.** Canadian Phytopathological Society. Printed by Central Duplicating Service, Univ. Manitoba, Winnipeg, Man.

Cormack, R. 1972. **Wild Flowers, Banff, Jasper, Kootenay, Yoho — National Parks.** 72 p. Available Information Canada Bookstores, Ottawa, Halifax, Montreal, Toronto, Winnipeg, Vancouver.

†Environment Canada. 1973. **A Pollution Primer; The Environment Needs You;** and **The Clean Air Act.** Three new publications which are available in bulk quantities. Enquiry Cenre, Information Branch, Environment Canada, Ottawa, K1A 0H3.

Environment Canada. 1973. **Index to Canadian Citizen's Environmental Organizations.** Information Branch, Environment Canada, Ottawa, K1A 0H3. 16 p. free.

†Herlocker, D. J., and H. J. Dirschl. 1972. **Vegetation of the Ngorongoro Conservation Area, Tanzania.** Canadian Wildlife Service Report Series No. 19. 40 p. $1.25. Available Information Canada Bookstores.

†Kuyt, E. 1972. **Food Habits of Wolves on Barren-ground Caribou Range.** Canadian Wildlife Service Report Series No. 21. 36 p. $1.00. Available Information Canada Bookstores.

Legget, R. 1972. **Rideau Waterways.** 2nd ed. University of Toronto Press, Toronto. 263 p. $10.00 cloth, $3.50 paper. This new edition includes references to new developments such as the St. Lawrence Seaway, the Cornwall-Messina development, the Carillon hydro-electric plan on the Ottawa River; as well as the latest information about maps and charts and fishing regulations; sailing on the waterways; new bridges and their clearances.

Macins. V. **1972.** The Fisheries of the Lake of the **Woods.** Information Branch, Ministry of Resources, Parliament Buildings, Toronto. $1.00. An informative account of the lake and its fishes.

MacCrimmon, H., and B. Lowe Gots. 1972. **Rainbow Trout in the Great Lakes.** Information Branch, Ministry of Resources, Parliament Buildings, Toronto. $1.00. A documented story of the rainbow trout from the Pacific Coast from about a century ago to now.

†May, C. P. 1972. **A Book of Insects.** St. Martin's Press, New York and Macmillan of Canada, Toronto. 119 p. $4.95. Illustrated by John Crosby.

†Mundy, K. R. D., and D. R. Flook. 1973. **Background for Managing Grizzly Bears in the National Parks of Canada.** Canadian Wildlife Service Report Series No. 22. 34 p. $1.00. Available Information Canada Bookstores.

†Newbury, R., and G. Malaher. 1973. **The Destruction of Manitoba's Last Great River.** Canadian Nature Federation Special Publication No. 2. 24 p. $1.00. 46 Elgin St., Ottawa, K1P 5K6. A critique of the proposed plan to divert the Churchill River to increase the flow on the Nelson River in order to create water reservoirs sufficient for power generation purposes.

†Parker, G. R. 1972. **Biology of the Kaminuriak Population of Barren-ground Caribou. Part 1. Total Numbers, Mortality, Recruitment and Seasonal Distribution.** Canadian Wildlife Service Report Series No. 20. 96 p. $1.50. Available Information Canada Bookstores.

†Peterson, R. L. 1972. **Systematic Status of the African Molossid Bats *Tadarida congica, T. niangarae* and *T. trevori*.** Life Sciences Contribution No. 85, Royal Ontario Museum, Toronto. 32 p. $2.00.

†Quilliam, Helen R. 1973. **History of the Birds of Kingston, Ontario.** 2nd ed., rev. Kingston Field Naturalists, P.O. Box 831, Kingston, Ont. K7L 4X6. 209 p. $4.95.

Robertson, J. A., and K. D. Card. 1972. **Geology and Scenery.** Information Branch, Ministry of Resources, Parliament Buildings, Toronto. $2.00. The fourth in the series of geological guide books for rockhounds, travellers, and geologists.

Rutter, R. 1972. **Birds of Algonquin Park.** Information Branch, Ministry of Resources, Parliament Buildings, Toronto. $.50. Lists 213 species and gives a general account of each found in the park.

Shih, C.-T., and E. H. Grainger. 1971. **A Synopsis of Canadian Marine Zooplankton.** Fisheries Research Board of Canada Bulletin 176. 264 p.

†Tuck, G. L. M. 1972. **The Snipes.** Canadian Wildlife Service Monograph Series No. 5. 428 p. $7.25. Available Information Canada Bookstores.

Miscellaneous

Batsford, B. T. 1972. **Natural Science Books in English 1600-1900.** David Knight, London. 262 p. £6.50. Bibby, C. 1972. **Scientist Extraordinary: The Life and Scientific Work of Thomas Henry Huxley, 1825-1895.** St. Martin's Press, New York. 208 p. $8.95.

Casper, M. S. 1973. **Liquid Fertilizers.** Noyes Data Corp., Park Ridge, N.J. 266 p. $36.00. Chemical Technology Review. No. 1.

*Chisholm, Anne. 1972. **Philosophers of the Earth.** E. P. Dutton Co., New York. 201 p. $10.75. Available from Clarke Irwin Co., Toronto.

Colbert, E. H. 1973. **Wandering Lands and Animals: The Drifting Continents and the Spread of their Animals Through the Ages.** E. P. Dutton Co., New York. $11.50. Available from Clarke Irwin Co., Toronto. The man responsible for the Continental Drift theory tells the story of the shifting of the land masses and the evolution and distribution of their animals.

Corner, G. W. 1972. **Doctor Kane of the Arctic Seas.** Temple Univ. Press, Philadelphia, Pa. 306 p. $10.00.

DeRopp, R. 1972. **The New Prometheans: Creative and Destructive Forces in Modern Science.** Jonathan Cape Co., London. 288 p. £2.95.

Duffey, E., and A. S. Watt. 1972. **The Scientific Management of Animal and Plant Communities for Conservation.** Blackwell Scientific Publications, Oxford, London. 576 p. £8.50.

Goldwater, L. J. 1972. **A History of Quicksilver.** York Press, Baltimore, Md. 318 p. $15.00.

Gould, R. F. [Ed.]. 1972. **Fate of Organic Pesticides in the Aquatic Environment.** American Chemical Society, New York. 280 p. $10.50.

Hollingsworth, M. J., and K. Bowler. 1972. **Principles and Processes of Biology.** Chapman and Hall, London. 466 p. £5.00.

Jacobson, M., and D. G. Crosby [Eds.]. **Naturally Occurring Insecticides.** Marcel Dekker, Inc., New York. 585 p. $33.75. Discusses botanical, insect-derived, bacterial and fungal insecticides.

Jeffers, J. N. R. 1972. **Mathematical Models in Ecology.** Blackwell Scientific Publications, Oxford, London. 408 p. £ 5.50.

Jones, D. P., and M. E. Solomon [Eds.]. 1973. **Biology in Pest and Disease Control.** Blackwell Scientific Publications, Oxford, London. 272 p. £5.00.

Jones, H. R. 1973. **Waste Disposal Control in the Fruit and Vegetable Industry.** Noyes Data Corp., Park Ridge, N.J. 259 p. $36.00. Pollution Technology Review No. 1.

Krebs, C. J. 1972. **Ecology: The Experimental Analysis of Distribution and Abundance.** Harper and Row Pub., New York. 694 p. $14.95.

Krutilla, J. V. [Ed.]. 1973. **Natural Environments: Studies in Theoretical and Applied Analysis.** Johns Hopkins Univ. Press, Baltimore, Md. 352 p. $18.97. Available from Copp Clark Co., Toronto and Montreal.

Laybourn, K., and C. H. Bailey. 1972. **Teaching Science to the Ordinary Pupil.** Barnes and Noble, New York. 2nd ed. 480 p. $12.50.

Luckner, M. 1972. **Secondary Metabolism in Plants and Animals.** Chapman and Hall, London. 418 p. £8.00.

*Assigned for Review.

MacArthur, R. H. 1972. **Geographical Ecology: Patterns in the Distribution of Species.** Harper and Row, New York. 288 p. $12.95.

Monod, J., and E. Borek. 1971. **Of Microbes and Life.** Columbia Univ. Press, Irvington, N.Y. 312 p.

*Patil, G. P., E. C. Pielou, and W. E. Waters [Eds.]. **Statistical Ecology. Vol. 3. Many Species Populations, Ecosystems, and Systems Analysis.** Pennsylvania State University Press, University Park, Pa. 462 p. $14.50.

Patten, B. C. [Ed.]. 1972. **Systems Analysis and Simulation in Ecology.** Academic Press Inc., New York. Vol. 2. 592 p. $27.50.

Popper, K. R. 1972. **Objective Knowledge: An Evolutionary Approach.** Clarendon Press, Oxford, U.K. 380 p. £1.50 paper, £4.50 cloth.

Russell, F. 1973. **The Sea Has Wings.** E. P. Dutton Co., New York. $10.95. A written and photographic tribute to the world of Atlantic seabirds. Available from Clarke Irwin Co., Toronto.

Savory, T. H. 1971. **Latin and Greek for Biologists.** Bonn Industries, Plainfield, N.J. 34 p. $4.00.

Schlee, Susan. 1973. **The Edge of an Unfamiliar World: A History of Oceanography.** E. P. Dutton Co., New York. $11.50. Available from Clarke Irwin Co., Toronto.

†Schopf, T. J. M. [Ed.] 1972. **Models in Paleobiology.** Freeman, Cooper and Co., San Francisco. 250 p. $9.40.

Taylor, S. A. 1972. **Physical Edaphology: The Physics of Irrigated and Nonirrigated Soils.** W. H. Freeman Co., San Francisco. 533 p. $17.50.

Ursin, M. J., and L. G. Clark. 1972. **Life In and Around the Salt Marshes: A Handbook of Plant and Animal Life In and Around the Temperate Atlantic Coastal Salt Marshes.** Thos. Y. Crowell Co., New York. 110 p. $4.95. Excellent field guide to 250 species, from plankton to land animals.

Usinger, R. L. 1972. **Autobiography of an Entomologist.** Pacific Coast Entomological Society vol. 4. 330 p.

Waddington, C. H. [Ed.]. 1972. **Biology and History of the Future.** Edinburgh Univ. Press, Edinburgh. 90 p.

Wielgolaski, F. E. and T. Rosswall [Eds.]. 1972. **Tundra Biome.** Proc. IV Int. Meeting on Biological Productivity of Tundra. IBP, Stockholm. 320 p. $4.00.

Yousef, M. K., S. M. Horvath, and R. W. Bullard [Eds.]. 1972. **Physiological Adaptations: Desert and Mountain.** Academic Press Inc., New York. Environmental Science: An Interdisciplinary Monograph Series. 258 p. $14.50.

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Cover photograph: Mixed pitch and white pine on thin soil at tip of Camelot Island, St. Lawrence Islands National Park, by John G. Woods. See articles — on national parks, page 211, and on pitch pines, page 249.

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The Role of National Parks in Canada and Criteria for their Management

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Sheard, J. W. and D. A. Blood. 1973. The role of National Parks in Canada and criteria for their management. Canadian Field-Naturalist 87: 211-224.

Abstract. The policy for the administration of the National Parks has become more conservation oriented during the last decade. This trend is welcomed but some policy statements and the current management of the parks indicate that confusion remains as to how this policy can be made compatible with the rising demand for wilderness and other recreational experiences. It is suggested that the only solution to this impasse is to educate park visitors so that they understand the value of preserving large areas of natural landscape. This will best be achieved by greatly expanding, and changing the emphasis of, the current interpretive program so that it becomes relevant to the problems of an urban society and hence educational in a wider sense than has previously been considered necessary. The maintenance of ecological diversity, the provision of quality, nature-oriented recreation, and the use of parks as scientific control areas are three other criteria for the management of the national parks which are discussed. If management priorities are established in the same order the dual roles of preservation and recreation will be most easily and satisfactorily fulfilled in Canada's National Parks.

Introduction

The National and Historic Parks Branch of the Department of Indian and Northern Affairs is to be complimented on holding public hearings across the country to allow open discussion of the Provisional Master Plans which have been or are in the process of being prepared for each of the National Parks. The authors were involved in the preparation of a brief for the public hearings on Prince Albert National Park, Saskatchewan, and our interest in park matters stems from this, our professions, and our experience as members of the lay-public in using parks.

Briefs presented at the hearings fell largely into two categories, those from people wishing to maintain their vested interests within the parks, and from those who felt that the provisional master plans allowed too much scope for development and commercialization. We suspect that this pattern has been and will continue to be repeated across the country. Members of each group tend to be rather vocal since both find ample justification for their views in the National Parks Act, section 4 of which states that, "The Parks are hereby dedicated to the people of Canada for their benefit, education and enjoyment, . . . and . . . shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations." The conflict of purpose is obvious, the first group pointing to the words "benefit" and "enjoyment", not however, to "education," while the conservationists take their cue from the last part of the statement.

In defining our own position on the subject we rapidly came to the conclusion that the same conflict of purpose applies not only to the National Parks but to the environment of the whole nation. Parts of the subject matter of this essay are, therefore, somewhat wider than the title suggests. We have nevertheless retained the title because we believe the parks can be used to focus on some of the fundamental problems which face our technological society. We will also suggest that the key word in unravelling the whole complex of problems is "education," the very word that, with a few notable exceptions (Lucas 1970; Pimlott 1970), has received the least attention.

The National and Historic Parks Branch (NHPB) has recently been placing an increased

emphasis on the role of the parks system in the conservation and preservation of wilderness (NHPB 1964, 1969). This contrasts markedly with the earlier policy, which was primarily recreation oriented. Not surprisingly this shift of emphasis has confused many park users, particularly cottage owners and entrepreneurs who have a capital investment within parks as a result of previous policies. It seems clear that a blanket policy for all national parks is not feasible. Most, as a result of their previous usage, need to be zoned while others have become, as a result of excessive development, unsuitable as wilderness parks. Still others are not large enough to possess any area of true wilderness character within their boundaries. The latter should be reclassified and administered under different criteria. The NHPB has already made some tentative suggestions for such a classification (NHPB 1964, 1972). In this paper we direct our attention to the wilderness principle and its application in parks. In order to avoid any possible misunderstanding we cite the definition of wilderness adopted by the Canadian Society for Wilderness Conservation (Pimlott 1971).

> Wilderness is that part of our natural landscape which is sufficiently large and varied to constitute a more or less self-regulatory ecological unit, where man's interference with the land and associated natural communities of plants and animals is minimal, and where the beauty and the character of the landscape is such as to have aesthetic, cultural and scientific significance.

It has not been our intention to make an exhaustive review of the literature pertaining to park management, which has been well documented elsewhere (Nelson 1970). However, we feel that certain aspects of park management have not received the attention they merit. We propose that the primary objectives or criteria for the management of the national parks system should be the following:

1. Public education,
2. Maintenance of ecological diversity,
3. Provision of quality, nature-oriented recreation,
4. Scientific control and research.

The first three objectives are interrelated and are regarded as being of equal importance. However, if the priorities are taken in the order suggested we believe that the succeeding objectives will be most easily attained. These objectives should not be regarded as the only criteria that need consideration in park management nor their discussion as being completely definitive. Hopefully, however, some new directions are pointed to which may prove helpful to park administrators.

Public Education

Although we believe that the National Parks Act has been interpreted correctly in the policy statements (NHPB 1964, 1969) there are statements in this document that lead us to believe that senior administrators in the NHPB still lack an appreciation for the need to preserve natural ecosystems and lack an understanding of their role within the biosphere.

The statement "like other resources, the National Parks resource is valuable to man only when he can utilize it" certainly needs clarification or should be deleted from the document. (For a good discussion of "use" in this context and its changing meaning through time see Brown (1970).) This statement could, however, be taken as an arrogant statement, characteristic of our technological society because it implies that natural ecosystems are of no benefit to man in their primordial state. In fact it has been known for some time that these undisturbed areas cleanse our air and waters and that in their diversity of species we may have an insurance against ecocatastrophies. Biologists therefore have reason to believe that undisturbed ecosystems are a necessary part of our life support system (Odum 1971; Watt 1968).

Such an egocentric view of nature must be replaced by one of humility if man is to live in harmony with his environment, as he must to preserve some quality in his life. Hardin (1968) has argued convincingly that there is no technological solution to current environmental and population problems, rather that a solution will require the establishment of a new morality or "land ethic" to use the phrase coined by

Leopold (1966). This should be a priority objective in our national educational goals and the National Parks system could play a decisive part in bringing about this change by developing an educational program which goes far beyond the present interpretive program. To convey an appreciation of the sophisticated workings of natural ecosystems to a sometimes apathetic public is a challenge not to be accepted lightly. The results, however, could profoundly influence the national character and ensure that Canada remains a country in which it is a privilege to live.

Although some government agencies and universities are taking the first tentative steps towards educating the public to a new environmental awareness, the urgency of giving such programs priority has not been generally accepted. Existing programs have largely developed because of the dedication and drive of a few individuals. It is more discouraging when one realizes that our present education systems do not allow the public to evaluate the environmental choices available to them (DeBell 1970) and that none of the institutions of our society appear to be particularly well geared to take on this role. Government departments are increasingly concerned with solving the latest ecological crisis. University faculty are constrained by their one- to three-year grants-in-aid to undertake short-term research projects but are nevertheless expected to present the long-term solutions to students and the public. We submit that it is time research was carried out into the methods of creating a new environmental awareness and that this would be of more benefit to society than much biological research currently being undertaken. But who will supply the impetus and financial support for these studies? One such body could be the National and Historic Parks Branch. Because of its responsibilities for maintaining thousands of square miles of natural or semi-natural terrain for the benefit of the people of Canada, it would seem to be very much in its own interest to institute such a program. It is not suggested that existing personnel undertake this task but rather that additional staff be hired specifically for the purpose. One would hope that it would be possible to second specialists from the fields of ecology, geography, sociology, primary and secondary education, urban planning, and related fields for periods of up to three years, not only from the universities but also from industry and other government departments. Only by such an integrated approach can we hope to come to grips with the fundamental problems of environmental education, conservation, and nature-oriented recreation.

We do not presume to know the answers to the educational problems we have posed but some of the difficulties that will have to be confronted are readily recognized. Basically a method has to be found for conveying an appreciation of the enormous and fascinating complexity of ecosystems to the public in a meaningful way. Anyone who has taught ecology knows the difficulty, and Morrison (1967) has stated it succinctly as follows, "Young people are not attracted to complex problems because they recognize the lack of an adequate methodology, and the methodology remains inadequate because few first class people are motivated to improve it." Dansereau (1970) has also commented on the lack of formalized laws governing the processes within environmental structures around which curricula can be developed.

To convey the message successfully it may be necessary to re-educate biology teachers and park naturalists before headway can be made. This is because traditional biological curricula have placed too much emphasis on the experimental method and this has unwittingly led to a simplistic view of biological systems amongst many educators, administrators, and the public at large. The experimental method is a reductionist procedure borowed from the sciences of chemistry and physics, involving the control of as many variables as is feasible and the experimental manipulation of single components of the system under study to elucidate their function, be the system a cell, an organism, or an ecosystem. There is no denying that the approach has been very successful in some fields of biological research, but the application of the experimental method by itself has not been and, we suspect, will not be very helpful in

leading us to an understanding of such complex biological features as growth and senescence, community structure and dynamics, or of evolution. The sum of our experimental results cannot be expected to give us a working knowledge of the whole system under study because it ignores interaction between the components of the system, controlled in experimental methodolgy, but of paramount importance in the real world. What is needed, therefore, is a more holistic methodology, now available in such techniques as systems analysis and multivariate statistics. Forester (1968) is of a similar opinion, according to his opening statement, but only rarely have such methods been applied to parks' problems (Hart 1966; Ream and Ohmann 1971). The former is an example of a conceptual aproach to systems, the latter of a sophisticated mathematical model.

Most of the scientific endeavours of biologists are therefore based on a reductionist philosophy, which overlooks the fact that biological systems are steady-state rather than equilibrium systems. Morowitz (1968) explains the difference between these two by stating that in the former "there is a continuous net flow of either matter or energy through the system from and to external reservoirs." Thus in biological systems we have the flow of energy from a source, the sun, to an energy sink, space. The central theme of Morowitz's work is that the flow of energy through steady-state systems serves to organize those systems. He further illustrates one aspect of this organization by showing that when energy flows through such systems cyclical reaction sequences are generated. Cycles are, of course, characteristic of many biological processes, and of ecosystems in particular. Perhaps we have here one of the elusive laws to which Dansereau (1970) was referring.

With these biophysical principles at hand, events such as the origin of life are more readily explained and can be seen as the inevitable consequence of energy flowing through primitive biochemical systems, the tendency to increasing order later continuing through organic evolution. In fact, the probability of life originating in a system governed by the laws of equilibrium thermodynamics has been demonstrated by Morowitz (1968) to be vanishingly small.

Some of these ideas may seem academic at first but if they were introduced into curricula at an early enough stage, and in a more simple and better argued manner, it might be possible to accept and respect the complexity of ecosystems as a fact of life in much the same way as we do certain physical laws. We do not need the laws of gravity to be proven to us each time we see an apple fall, we accept such an incident as a consequence of the laws more or less as an act of faith. As an example, the tranquility of many park vistas (Figure 1) is due not so much to their solitude as to the fact that they appear to the visitor as stable and permanent in contrast to his usual urban environment. It should not be impossible to explain that this stability is due to the energy flowing through and maintaining the ecosystem before him. Such an approach would be more stimulating to many than the purely descriptive approach which has characterized much park literature and naturalists' talks.

The fact that biological systems are able to increase their order with time, exemplified by community succession as well as evolution, does not conflict with the laws of equilibrium thermodynamics. It merely represents an interruption in the general tendency towards disorder in the universe as a whole. The temporary reversal in the process is made possible by organisms, steady-state systems, trapping solar energy and their subsequent expenditure of that energy. In other words it "costs" energy to achieve increasing order and stability. This contrasts markedly with everyday experience.

Urban man is increasingly surrounded by objects which are part of an equilibrium system and which therefore tend to disorder as dictated by the second law of thermodynamics. Concrete decays and buildings crumble, cars suffer metal fatigue of various types and are deposited on scrap heaps; the list is interminable. It is true that many jobs are created and much energy is exerted in an atempt to halt this disordering process but few apear to have considered the depressing effect this may have on our psyche, man having evolved in a steady-state ecosystem

FIGURE 1. The tranquility of many park vistas is due not so much to their solitude as to the fact that they appear to the visitor as stable and permanent in contrast to his usual urban environment. Bow River Valley, Banff National Park. J. W. Sheard, photographer.

capable of maintaining itself indefinitely. What better facility could there be than the national parks, with a captive audience surrounded by a steady-state enivronment, to bring to public attention some of the limitations of a technological society? Nor should it be surprising to find that the principles which govern plant and animal communities can also be applied to human society although man's egocentricity has not allowed him to look to natural systems for guidance in his endeavours. Margalef (1963) has observed that energy usually flows from simple to more diverse communities. The depopulation of rual areas might therefore be seen as predation by urban centers which have a greater diversity of job opportunities and economy but which become progressively less manageable with their growth. If we wish to maintain rural communities as a part of our culture then we must build diversity into them and reverse the trend toward centralization, accepting some loss of economic efficiency to ensure their survival.

It is hoped that some of the thoughts in the previous paragraphs will suggest the direction in which educational processes might be guided to create a situation in which an environmental ethic can evolve. In view of the educational objective of the parks as stated in the National Parks Act it is disturbing to note the NHPB statement that "it is not properly a part of its function to undertake the writing of textbooks" (NHPB 1971). This may not be the best way of fulfilling its educational responsibilities but some type of relatively novel publications will certainly be necessary as part of the educational program that is required. The United States National Parks Service is already leading the

way in this field (Anonymous 1970; Gilbert 1972) and has valuable experience which might be drawn upon.

The present interpretive program should therefore be greatly expanded and become an integral part of this educational program. It has also been suggested to us that in off-peak times school parties should be encouraged to visit and stay in parks for periods of up to two weeks, and that facilities and resource personnel be provided for them. We furthermore recommend that interpretive facilities be relocated, where necessary, so that nature trails can radiate out into a variety of habitats from them. We urge the abandonment of the museum concept and adoption of the idea that the prime function of the interpretive center is to "motivate the viewer into looking for the real thing outside" (Edwards 1970). It is also unfortunate that despite the fact that a strong case was made for an increased role of naturalists in planning and management of Canadian National Parks almost a decade ago (Stirrett 1963), they still seem to be regarded largely as public relations men or entertainers (Cunningham 1970). We feel that the park naturalist has two major functions, firstly to interpret nature in its widest sense to the public, and secondly to provide a scientific input to park management.

Any educational program will have to be imaginative to succeed in bringing humility to a technocratic nation. Ready analogies, as we have seen, do exist which may help to resolve this problem. The comparison of energy networks within ecosystems to the printed circuits of our electronic gadgetry which are so widely appreciated is another example which might be helpful. Such an analogy plays down the complexity of the real situation since ecosystem function is more comparable to that of a hypothetical analogue computer which is able to program its own design and reproduction. Such a computer, of course, has not been built because man is not capable of designing the feedback loops delicate enough to achieve and sustain the process. Yet this is precisely how ecosystems function, the necessary feedback loops having been subject to natural selection in the process of organic evolution through the ages.

It is our opinion that park administrators must heed the lesson of the ecosystem and establish a feedback from park users through a greatly expanded and upgraded educational program. Otherwise, the restriction of certain recreational activities within parks under the new administration policies, although necessary, will only serve to alienate many of the current users. A sound educational policy may also allow a greater throughput of visitors than would otherwise be possible, but at some time in the foreseeable future entrance to the National Parks will have to be restricted if the present trends of population growth and mobility are continued. Despite the recent addition of the three northern parks, the increase in park area is not keeping pace with the park usage (Sheppard 1972). Although the parks are publicly owned, it does not follow that it is a public right to have unlimited access. To allow unrestricted access to parks will inevitably lead to yet another incident in the "tragedy of the commons" (Hardin 1968), a result of the public assumption that man has the right to exploit a resource which has no readily identifiable owner. If this is allowed to happen, it will not be possible to maintain the parks "unimpaired for the enjoyment of future generations."

Maintenance of Ecological Diversity

We believe that maintenance, and improvement where necessary, of ecological diversity in the National Parks must be a major goal if optimum national social benefit is to be obtained. The immense, if often intangible, value of ecological diversity has been eloquently stated by several scientists (e.g. Dasmann 1968; Pimlott 1969), and will not be discussed in detail here. For purposes of this discussion, optimum and desirable biotic diversity is considered to be that arrived at through natural ecosystem development, un-influenced by activities of modern man.

In the National Park context, diversity can be seen to have two main values. The first is the aesthetic, inspirational, and educational value

to the visiting public of an area diverse in natural elements, interacting in a natural way. A complete park experience is not achieved if some natural elements of ecological processes are missing.

Secondly, much less expenditure of management effort is required if natural diversity and ecosystem processes are present. The introduction of artificiality, biotic simplification, and interference with natural processes in National Parks all serve to disrupt ecological homeostasis. While it has been generally accepted that ecological or biotic diversity tends to enhance community stability, Odum (1969) points out that "the cause-and-effect relationship between diversity and stability is not clear and needs to be investigated from many angles."

While the effects of biotic simplification alone cannot be readily separated from the effects of other human interferences, our knowledge of Canada's Western National Parks suggests that these factors together do reduce community stability. One could arrange those parks in a sequence from highly simplified and artificial (Elk Island) to essentially undisturbed (Kluane). Upon examining the vegetation–ungulate–carnivore relationships in those parks we see that Elk Island, with its small size, completely fenced perimeter, and lack of large predators has experienced violent fluctuations in its ungulate populations, with comparably violent effects on the vegetation. Controlling these fluctuations and maintaining good range conditions has required a considerable management effort. In the nearly natural situation at Kluane, wolves and bears help to control ungulate levels. In addition, the large size of this park, plus the ability of mobile species to migrate to and from it, help to maintain stability. Other parks fall at various points between these two extremes, depending upon their size, use of land immediately surrounding them, man-caused alterations within them, and the degree of simplification of their flora and fauna. These comparisons are a graphic example of the diversity–stability relationship, and as such should be an integral part of the educational experience of park users and the general public.

In considering diversity, stability, and ecological processes in National Parks then, we must recognize that the biota and physical landscapes of the parks have been and are being altered by man, and that the source of these external perturbations can be far removed. For example, land clearing around some parks has altered the water table in them, weeds from distant areas have invaded most, the W.A.C. Bennett Dam has severely altered the ecology of the Peace-Athabasca Delta in Wood Buffalo Park (Dirschl 1972), and pesticide contamination is virtually universal.

To achieve the goal of biotic diversity in parks which have been modified in varying degrees, management based on scientific research and inventory is not only desirable but essential (see Figures 2 and 3). Our concept of management in the National Park context is essentially that of Bourliere (1962), who defined it as follows.

> Management is defined as any activity directed toward achieving or maintaining a given condition in plant and/or animal populations and/or habitats in accordance with the conservation plan for the area. A prior definition of the purpose and objectives of each park is assumed.
>
> Management may involve active manipulation of the plant and animal communities, or protection from modification or external influences.

As pointed out by Houston (1971), management of a park ecosystem "generally involves preventing or compensating for man's altering of natural ecological relations."

The kind and degree of management effort required to maintain or improve diversity will, of course, vary with the size, location, and historical alteration of each park. In large remote parks such as Kluane and Nahanni, management must be restricted to "protection from modification or external influences" (although all parks should receive this protection). The term 'management' then, includes strict protection as well as active manipulation.

Whether or not diversity can be maintained by protection alone would seem to vary with

FIGURE 2. Restricted or fragile communities in National Parks must be recognized, described, and afforded protection from excessive recreational use. Parkland, Riding Mountain National Park. D. Blood, photographer.

the nature of the park. Stone (1965) has stated that "since vegetation is never static, preservation must consist, in effect, of managing change." However, in the case of large wilderness parks there would seem often to be no value in manipulation of natural successional or evolutionary changes in existing ecosystems. In these areas management would thus follow the "evolutionary" rather than the "era" concept.

In other parks, neither the era nor evolutionary concepts should be applied rigidly to all lands. In the case of the physical landscape however, the evolutionary concept should generally be followed so that natural erosion, siltation, and hydrological processes are allowed to proceed. Where physical features, which have been altered in the past by man, can be restored to a previous natural state, we recommend restoration to the condition in which they were at the time the park was established.

The aim of conservation of vegetative diversity will vary with the history of logging, fire (or fire control), cattle grazing, and related disturbance. In general we agree with the Leopold Committee recommendation for U.S. National Parks (Leopold et al. 1963) which stated that ". . . the biotic associations . . . be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man." This might involve encouragement of natural regeneration of coniferous trees where these have been removed by logging, or controlled burning to prevent the encroachment of aspen and shrub into meadows formerly maintained by natural wildfire.

Faunal diversity and individual species abundance are, of course, largely dictated by the state of the vegetation. Thus the general objective for faunal management would be the same as for the plant cover. Where possible, large predators and perhaps other species which have formerly occurred in the parks should be re-introduced.

In order to protect and manage the National Park landscape with the objective of natural ecological diversity, certain policies must be

FIGURE 3. Poor trail design and excessive use have resulted in severe damage to some National Park landscapes. Banff National Park. G. Trottier, photographer.

accepted. We are pleased to note that a strong move toward development of such a policy is indicated in several National Park Master Plans and in the National Parks Policy statement (NHPB 1964) but would like to re-enforce or expand certain aspects.

1. National Park planners must recognize the great complexity of ecosystems and the many management procedures needed to maintain them.

   As an example, it appears that vegetation control, probably with the use of fire, is necessary to halt encroachment of shrub and tree growth into the few fescue meadows in Prince Albert National Park (Carbyn 1971).

2. Management must be limited to native species, or to the reduction or removal of certain exotic species which already occur.

While the policy of not introducing exotics is already in effect, no concerted effort seems to have been made to reduce or eliminate exotic species either purposefully or accidentally established in the past. In some parks serious invasion by weeds has taken place, primarily as a result of cattle grazing (Blood 1966) or recreational use of horses. While cattle grazing has now been eliminated, the use of horses continues to increase. While we are in favor of this primitive mode of transportation, we feel it must be carefully managed by park officials. Unrestricted ingress of privately owned horses should not be allowed. Horses used in National Parks should be fed only native forage or weed-free commercial rations. They should not be allowed to forage at will along trails where weeds have already

been introduced. If a major effort is made to halt further invasion of weeds, the existing problem may largely correct itself through natural ecological succession. Where this is not the case, efforts should be made to eradicate exotic plants and to promote the establishment of native species.

The policy toward exotic species should apply to all parts of the parks. We are opposed to the present policy of using exotic trees and shrubs for landscaping purposes in "built up" areas (NHPB 1964). Native species should suffice for this purpose.

Exotic fishes have also been introduced in a number of National Parks, e.g. Prince Albert (Rawson 1945). Serious studies need to be undertaken to determine the possibility of removal of exotic fishes, and to prevent the spread of those which cannot be removed.

3. A program of research must be considered a necessary prerequisite to all management activities.

While this policy is accepted by National Park planners, we do not feel it has been adequately pursued. For example, the development of a number of recreational activity centers proposed for the National Parks would be premature without further research.

A number of other matters urgently requires study. Foremost among these are the relationship of carnivore–herbivore–vegetation biomass components to community stability, and the impact of increasing visitor use on flora and fauna. Imaginative research programs are needed to determine optimum levels of non-consumptive use of wildlife (Figure 4). The greatest challenge in park management today is to bring more people into contact with wildlife (and nature generally) without danger to either. Geist (1971) has suggested how the behavioral attributes of ungulates can accommodate such a fruitful interaction. A related problem is the interaction between visitors and bears. The objective here should be to seek innovative ways of achieving a harmonious interaction, rather than discouraging all contact between the two species. Studies of human behavior in the presence of wildlife are as badly needed as research on behavior of the wildlife species themselves.

4. A scientific advisory committee should be established for each park to consider technical problems related to park management, and particularly to coordinate activities outside the park which affect the park and vice versa.

The scientific committee could consist of specialists employed by government, universities, and other institutions. It should report to a management committee composed only of federal and provincial government administrators with direct responsibility for management of lands and resources in and surrounding the parks. Some items which should be considered are the following:

a. Establishment of a buffer zone around each park in which land use and management practices are designed to reduce direct impact on the park. Within such zones, provincial and private agencies would be encouraged to adopt less disruptive resource exploitation methods than practised elsewhere in the provinces or territories, and thus reduce the sharp contrast between park lands and their immediate surroundings. An example might be to decrease predator control activities adjacent to smaller parks which cannot maintain desirable wolf numbers as a result of egress and subsequent mortality. Another is the joint recreational management of mobile ungulate populations;

b. Exclusion of exotic species from the parks. An example here would be the restriction of exotic fish introductions from waters which flow directly into National Parks;

c. Fire protection and/or use for management purposes. Coordination of fire control and the use of fire is needed so that natural wildfires in parks are allowed to run their course, accidental man-

FIGURE 4. Imaginative research programs are needed to determine optimum levels of non-consumptive use of wildlife in National Parks. Bighorn ram, Banff National Park. Photographer unknown.

caused fires extinguished, and prescribed fires manipulated for the maximum benefit of both park and non-park lands;

d. The achievement of desirable boundary changes. Full coordination is required to ensure that boundary changes support the objective of making each park as self-contained an ecological unit as possible.

Provision of Quality, Nature-oriented Recreation

It is recognized that a high quality, recreative, inspirational experience for one person may not be so for another. Thus the components of such an experience are difficult to define. However, we believe that quality recreation in the National Parks should be based on enjoyjoyment of the *natural* rather than artificial features. Thus the parks should strive to serve those people seeking essentially natural wilderness or semi-wilderness enjoyment. The requirements for such an experience are perhaps best stated in the negative sense, i.e. what factors should be avoided? We feel that the following are the factors which detract most significantly from desirable recreational enjoyment of National Parks, and which park management should strive to avoid:

1. Human crowding,
2. Non-natural noise,
3. Unsightliness or artificiality,
4. Inadequate provision for wilderness enjoyment, travel, and safety.

Human Crowding

More and more people are seeking a true wilderness experience and go to National Parks

to satisfy their desire to escape from the stresses of modern society. This experience can only be achieved through minimal contact with other humans. No matter how natural or wild the landscape is, it is not wilderness if it contains too many people. We feel that increased effort is needed to ensure that crowding is reduced in non-urbanized areas.

Total size of campgrounds and human density in them must also receive more consideration, since damage to vegetation as well as a loss of wilderness enjoyment can result. This has been documented in at least one National Park (deVos and Bailey 1970).

Non-natural Noise

Motor noises detract greatly from human enjoyment of wildlands and wildlife, and may disturb animals directly, or interfere with the nesting of birds. They also make wildlife observation more difficult for those whose prime desire it is to watch or photograph animals.

For these reasons we feel that the use of motor boats in National Parks should be severely restricted. Increased use of high-speed outboards has a potential for insidious long-term impact on water-nesting birds such as loons, grebes, and diving ducks. Marshy bays in large lakes on which motors are allowed should be zoned against motorboat access during spring and early summer. In addition, the government should take the initiative in introducing non-polluting, quiet, electric motors on large lakes where motorized transport is necessary for safety or other reasons.

We feel that the current restriction on the use of trail bikes, all-terrain, and over-snow vehicles in Canada's National Parks should be maintained indefinitely. As well as detracting from wilderness enjoyment in the same way as motorboats, they are potentially damaging to the plant cover.

Artificiality

We concur with the Leopold Committee recommendation for U.S. National Parks that ". . . observerable artificiality in any form must be minimized and obscured in every possible way" (Leopold et al. 1963). In this regard it would be preferable if existing townsites were located completely outside the park boundaries. Since this is not the case, the National Parks administration should proceed at once with its stated aims of (1) limiting townsite growth, (2) renovating townsites to conform with the park landscape, and (3) encouraging further commercial enterprise to establish itself outside park boundaries.

More initiative must be taken to establish federal–provincial agreement to tackle the latter problem. In many cases park visitors could be quite adequately served by peripheral developments. Thus the argument that ever more facilities, particularly modern accommodation, must be provided inside parks to satisfy the upward trend in park use does not appear to be well founded.

We feel too that private entrepreneurs in the parks have been allowed too much freedom in the construction and operation of commercial facilities, and that this has contributed greatly to the problem of artificiality. The profit motive in private enterprise is not conducive to the establishment of facilities in harmony with ideal National Park use and management, and its place in these parks must be seriously questioned. The stated policy (NHPB 1969) that "Development and operation of permanent accommodation in National Parks should be by private enterprise" should be seriously and critically reviewed.

The other major source of introduced artificiality is that of roadway construction. Much more consultation with ecologists and landscape planners is needed to ensure that roadway standards are in harmony with the basic purpose of National Parks, i.e. wilderness enjoyment. Both aesthetic and ecological impact must be considered, and should not be overruled by the dictates of traditional engineering design. In general, a much more imaginative and radical departure from the conventional design of these and related facilities is required.

Inadequate Provision for Wilderness Enjoyment, Travel, and Safety.

We think that in this general area National Park administrators have failed to come to grips

with the true purpose of National Parks. While the generally adequate provision of family camping facilities is a notable exception, the provision for a more truly wilderness experience has been largely lacking. This stems from the fact that the development and operation of visitor facilities (except campgrounds) has been left largely to private entrepreneurs, and since wilderness pursuits are not highly profitable, they have been ignored. Private enterprise would rather see wilderness zones opened to paved roads, motor hotels, and gas stations used by large numbers of people, than cater to fewer people seeking a wilderness experience.

Thus, again, the motives of private enterprise do not satisfy the long-term objectives of National Park preservation and use. There is an urgent need for the govrnment to show active leadership in the development and regulation of wilderness use, rather than letting the course of development be dictated by private enterprise, politics, and the apparent wants of the "lazy recreationist."

Since use of the public purse has been justified to provide highways and intensive-use recreational facilities for casual park visitors, many of whom are not interested in wilderness values, increased expenditure for wilderness enjoyment should also be warranted, and should receive much higher priority.

National Parks as Scientific Control and Research Areas

This need has been described by Cragg (1970) and the concept has been clearly stated by Pruitt (1970) who said:

> . . . without control areas the resource manager cannot discern whether his new cutting program, for example, or his new harvest regulations, are an improvement over the old or whether any changes observed are caused by long-term climatic shifts or maybe cyclic fluctuations in animal populations. I look upon this role as scientific control areas as the most important function of National Parks.

While we do not agree that this is the most important function of National Parks, it is certainly a significant one, and will become more so as surrounding lands are developed. As long as the preceding objectives of park management and protection are met, the role of parks as research and control areas should be assured. In this regard, we feel strongly that legitimate non-disruptive research should be permitted and encouraged in the National Parks, even if such studies are not directly for park purposes.

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Literature Cited

Anonymous. 1970. National Park Service educational programs. National Parks and Conservation Magazine 44(274): 16.

Blood, D. A. 1966. Range relationships of elk and cattle in Riding Mountain National Park, Manitoba. Canadian Wildlife Service, Wildlife Management Bulletin Number 19. 62 pp.

Bourliere, F. 1962. Management in National Parks Committee report. *In* The first world conference on National Parks. United States Department of the Interior. 471 pp.

Brown, R. C. 1970. The doctrine of usefulness: Natural resources and National Park Policy in Canada, 1887–1914. *In* Canadian Parks in perspective. J. C. Nelson (Editor). Harvest House, Montreal.

Carbyn, L. N. 1971. Description of the *Festuca scabrella* association in Prince Albert National Park, Saskatchewan. The Canadian Field-Naturalist 85(1): 25–30.

Cragg, J. B. 1970. Research in national and provincial parks: Possibilities and limitations. *In* Canadian Parks in perspective. J. G. Nelson (Editor). Harvest House, Montreal. pp. 111–122.

Cunningham, E. B. 1970. An ecologist's view of National Park operation and management. The Canadian Field-Naturalist 84(2): 191–194.

Dansereau, P. 1970. Megalopolis: resources and prospect. *In* Challenge for survival. P. Dansereau (Editor). Columbia University, New York. pp. 1–33.

Dasmann, R. F. 1968. A different kind of country. MacMillan, New York.

DeBell, G. 1970. Education and ecology. *In* The environmental handbook. G. DeBell (Editor). Ballantine, New York. pp. 129–133.

Dirschl, H. J. 1972. Evaluation of ecological effects of recent low water levels in the Peace-Athabasca Delta. Canadian Wildlife Service Occasional Papers, Number 13. 28 pp.

Edwards, R. Y. 1970. The plan to appreciate Canada. Canadian Audubon 32(3): 98–100.

Forrester, J. W. 1968. Principles of systems. Wright-Allen, Cambridge, Massachusetts

Geist, V. 1971. A behavioural approach to the management of wild ungulates. *In* The scientific management of animal and plant communities for for conservation. E. Duffy and A. S. Watt (Editors). The 11th Symposium of the British Ecological Society, 1970. pp. 413–424.

Gilbert, V. C. 1972. A widening horizon — the role of parks and reserves in education. Background Paper for Session XII (1), Second World Conference on National Parks. Unpublished manuscript.

Hardin, G. 1968. The tragedy of the commons. Science (Washington), 162(3859): 1243–1248.

Hart, W. J. 1966. A systems approach to park planning. IUCN (International Union for the Conservation of Nature and Natural Resources) Publication New Series, Supplemental Paper 4. Morges, Switzerland. xvi + 118 pp.

Houston, D. B. 1971. Ecosystems of National Parks. Science (Washington), 172(3984): 648–651.

Leopold, A. 1966. A Sand County almanac. Oxford University Press, New York, xi + 269 pp.

Leopold, A. S., S. A. Cain, C. Cottam, I. N. Gabrielson, and T. L. Kimball. 1963. Wildlife management in the National Parks. Transactions of the North American Wildlife and Natural Resources Conference, 28: 28–45.

Lucas, R. C. 1970. Research needed for National Parks. *In* Canadian Parks in perspective. J. G. Nelson (Editor). Harvest House, Montreal. pp. 284–309.

Margalef, R. 1963. On certain unifying principals in ecology. American Naturalist 97(897): 357–374.

Morowitz, H. J. 1968. The flow of energy in biology. Academic Press, New York. ix + 179 pp.

Morrison, R. S. 1967. Education for environmental concerns. *In* America's changing environment. R. Revelle and H. H. Landsberg (Editors). Houghton Mifflin, Boston. pp. 285–298.

NHPB (National and Historic Parks Branch). 1964. National Parks Policy. National Parks Branch, Department of Northern Affairs and National Resources, Ottawa. 32 pp.

NHPB (National and Historic Parks Branch). 1969. National Parks Policy. National and Historic Parks Branch, Canada Department of Indian Affairs and Northern Development, Ottawa. 21 pp.

NHPB (National and Historic Parks Branch). 1971. Decisions resulting from the public hearing on the provisional master plan for the Fundy National Park. National and Historic Parks Branch, Department of Indian Affairs and Northern Development, Ottawa. 18 pp.

NHPB (National and Historic Parks Branch). 1972. Byways and special places. National and Historic Parks Branch, Department of Indian Affairs and Northern Development, Ottawa. 71 pp.

Nelson, J. G. (Editor). 1970. Canadian Parks in perspective. Harvest House, Montreal. 343 pp.

Odum, E. P. 1969. The strategy of ecosytem development. Science (Washington), 164 (3877): 262–270.

Odum, H. T. 1971. Environment, power and society. Wiley-Interscience, New York. ix + 331 pp.

Pimlott, D. H. 1969. The value of diversity. Transactions of the North American Wildlife and Natural Resources Conference 34: 265–279.

Pimlott, D. H. 1970. Education and National Parks. In Canadian Parks in perspective. J. G. Nelson (Editor). Harvest House, Montreal. pp. 153–173.

Pimlott, D. H. 1971. Wilderness values in the twentieth century. *In* Why wilderness. Edited by B. M. Littlejohn and D. H. Pimlott. New Press, Toronto. pp. 13–21.

Pruitt, W. O. 1970 The Newfoundland National Park potential. The Canadian Field-Naturalist. 84(2): 99–115.

Rawson, D. S. 1945. The experimental introduction of smallmouth bass into lakes of the Prince Albert National Park, Saskatchewan. Transactions of the American Fisheries Society 73: 19–31.

Ream, R. R. and **L. F. Ohmann.** 1971. Analysis of wilderness ecosystems. *In* Statistical ecology 3. Patil G. P. et al. (Editors). Pennsylvania State University, University Park, Pennsylvania. pp. 123–131.

Sheppard, D. H. 1972. Population and our natural environment. Blue Jay 30(1): 2–5.

Stirrett, G. M. 1963. The role of natural history interpretation in the management of parks. Unpublished paper read at Technical Meetings, Second Federal Provincial Parks Conference, Ottawa. 29 pp.

Stone, E. C. 1965. Preserving vegetation in parks and wilderness. Science (Washington) 150(3701): 1261–1267.

deVos, A. and **R. H. Bailey.** 1970. The effect of logging and intensive camping on vegetation in Riding Mountain National Park. The Forestry Chronicle 46(1): 49–55.

Watt, K. E. F. 1968. Ecology and resource management: a quantitative approach. McGraw-Hill, New York. xii + 450 pp.

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Bird Mortality from Oil Slicks off Eastern Canada, February - April 1970

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Abstract. Oil slicks resulting from the "Arrow" and "Irving Whale" spills in February 1970 resulted in the known deaths of 1,500 ducks and seabirds, and an estimated total kill of at least 12,000 birds. The species principally affected were Oldsquaws, Red-breasted Mergansers, grebes, and murres in Chedabucto Bay, Nova Scotia; murres, Dovekies, and Fulmars between the Nova Scotian coast and Sable Island; and Common Eiders (subspecies *borealis*), murres, and Black Guillemots off southeast Newfoundland. The breeding populations to which some of these birds belonged are identified, and the overall effect of this mortality on the species as a whole is assessed. Only the kill of *borealis* eiders approached significance to the population of this subspecies. It is emphasized that the hazard presented by an oil spill depends on its position and timing as much as on its size.

Introduction

February 1970 was a particularly bad month for oil pollution along the Atlantic coast of Canada. On February 4, the 18,000-ton tanker "Arrow" ran aground in Chedabucto Bay, Nova Scotia, spilling roughly 2½ million imperial gallons of Bunker C fuel oil; about 450,-000 gallons of this came ashore in the Bay, but the rest moved out to sea. On February 14, the oil barge "Irving Whale" spilled between 3,000–7,000 gallons of Bunker C off the southeast coast of Newfoundland. Both incidents caused the deaths of large numbers of ducks and seabirds. The object of this paper is to describe the mortality in detail.

The data presented here were collected by Watson and Pearce in Chedabucto Bay, by Brown and Lock on Sable Island, and by Gillespie in Newfoundland; further details are on file with the Canadian Wildlife Service, Ottawa. Our fieldwork on birds made up only a small part of the intensive operations following the wreck of the "Arrow," which are summarized by McTaggart-Cowan *et al* (1970).

Sequence of Oil Spills and Movements

The "Arrow" went aground on February 4, and immediately started to leak oil; some of this (Slick A) moved out to sea the next day (see Figure 1). Away from the coast, the wind is the main factor influencing the drift of oil; oil tends to move with the wind, and at roughly 3.4% of the surface wind speed (e.g. Smith 1968). If the wind speeds and directions recorded at the meteorological stations at Canso in southeast Chedabucto Bay, and at Sable Island are used, it would appear that Slick A moved first south, and then east. On this drift model, there can be little doubt that the dense oil slick which, together with a large number of oiled seabirds, came ashore in the middle of the north side of Sable Island on February 27, was in fact Slick A. It is unlikely that much oil from this slick could have moved on beyond the island.

Meanwhile, oil from this and subsequent leaks came ashore with oiled birds all round Chedabucto Bay, up to about February 16. More oil (Slick B) moved out to sea on March

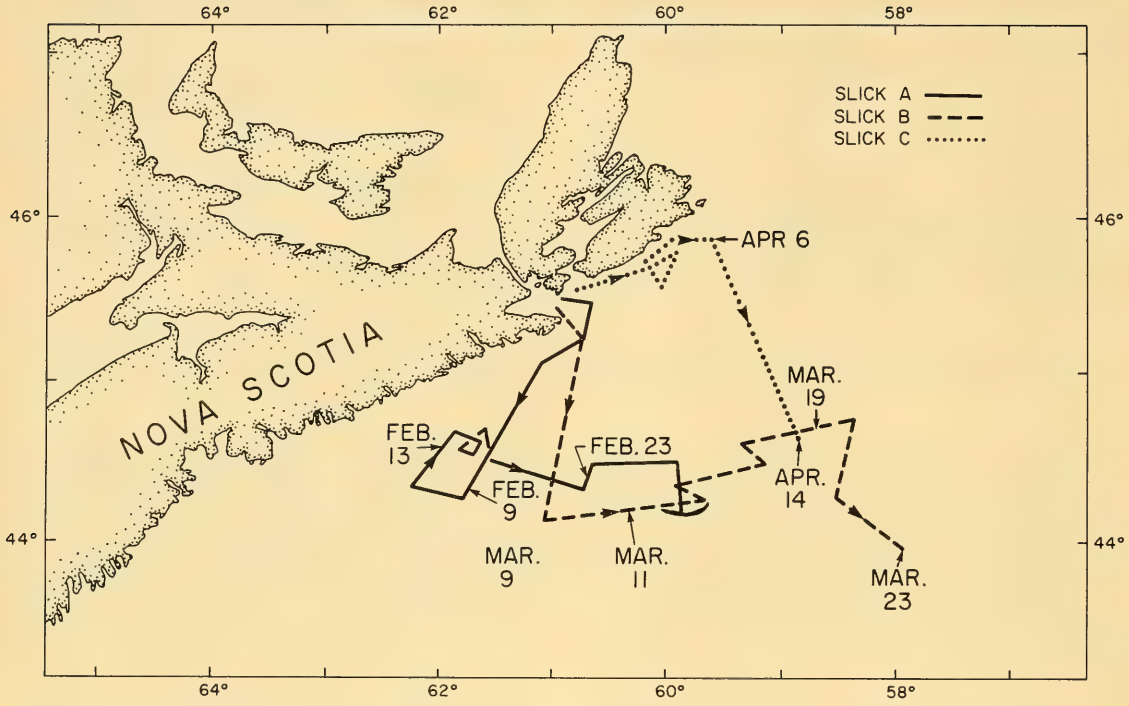

FIGURE 1. Predicted drifts of Slicks A, B, and C. Dates indicate predicted position at 0001 hours GMT on the day in question.

1; the drift model suggests that, like Slick A, it too moved south and then east (Figure 1). Oil and oiled birds were reported about 100 miles west of Sable Island on March 11, and more oiled birds came ashore on the island on March 13. The timing in both cases is close to the predicted drift of Slick B.

A fresh leak from the "Arrow' on March 25 also moved out to sea (Slick C). A report of oiled birds from Scatari Island in early April may refer to this slick — otherwise, its movements are unknown. The drift model suggests that it remained off eastern Cape Breton until about April 6, and then drifted off southeast (Figure 1).

The "Irving Whale" apparently started to spill oil, from a leaking plug, somewhere west of St. Pierre during a gale on or about February 14. Thick oil and oiled birds were soon reported all along the southwest tip of the Burin Peninsula. Northeast winds blew the oil offshore, apparently onto the southeast coast of Miquelon, where oil was reported on February 21. A thinner oil slick and lightly oiled birds were reported from St. Shotts, on the Avalon Peninsula, on March 1, and the slick moved

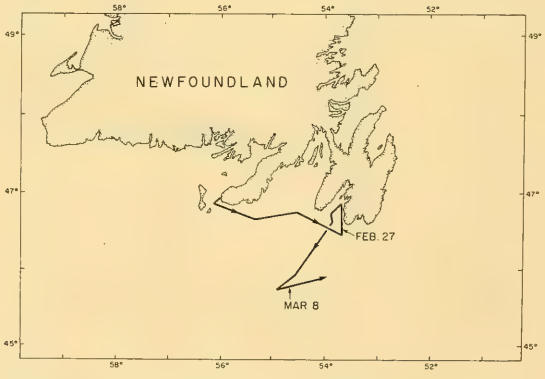

FIGURE. 2. Predicted drift of Slick D. Dates indicate predicted position at 0001 hours on the day in question.

out to sea from there on March 3. The drift model, using wind speeds and directions recorded at St. Lawrence, Burin Peninsula, leaves no doubt that the Burin and St. Shotts slicks were the same (Slick D; Figure 2), though for our purposes it is easier to treat them separately.

Bird Mortality

(a) Chedabucto Bay

Between February 9–16 we checked a total of 11.6 miles of beach in various parts of Chedabucto Bay. Table 1 shows the numbers of

TABLE 1. — The numbers of birds found oiled on beaches. (Live oiled birds are included in the totals.)

	Chedabucto Bay	Sable Island		Newfoundland	
		March	May	Burin	St. Shotts
Common Loon	1	1	4	1	1
Red-necked Grebe	5	0	0	1	0
Horned Grebe	28	0	0	0	0
Grebe sp.	30	0	0	0	0
Fulmar	0	29	43	0	0
Gannet	0	0	2	0	0
Black Duck	1	0	0	0	0
Common Goldeneye	4	0	0	0	0
Bufflehead	8	0	0	0	0
Oldsquaw	144	1	8	5	12
Common Eider	0	0	0	1	about 555
King Eider	0	0	0	0	1
White-winged Scoter	2	0	0	0	0
Scoter sp.	6	0	1	0	0
Red-breasted Merganser	40	0	0	0	0
Merganser sp.	0	0	1	0	0
Duck sp.	9	0	3	0	0
Gull sp.	3	0	no data	0	0
Razorbill	0	0	1	0	0
Common Murre	1	0	6	0	0
Thick-billed Murre	0	0	137	0	0
Murre sp.	38	122	175	25	2
Dovekie	16	57	57	0	0
Black Guillemot	7	5	1	12	4
Common Puffin	0	2	2	0	0
Seabird sp.	0	0	4	0	0
Bird sp.	7	0	0	5	0
Miles searched	11.6	1.8	9.6	3.2	5.0

NOTE: Additional data on dead birds outside the beach count areas:

Chedabucto Bay — Common Loon 4; Red-necked Grebe 1; Oldsquaw about 18; Common Eider 4; King Eider 3; Common Murre 4; Murre sp. about 18; Dovekie 1; Black Guillemot 1.

The numbers of oiled gulls found on the beaches is greatly below the number of oiled birds seen. One flock of 150 gulls included 50 partly, and 7 badly, oiled birds; another flock of about 200 included about 70 partly, and about 30 badly, oiled birds.

Sable Island — Leach's Petrel 8; Gannet about 10 — both species in March.

At least one oiled Great Black-backed Gull was found on the May count. An additional Common Murre found in May away from the sampled beaches.

Burin Peninsula — Loon sp. 3; Red-necked Grebe 1; Oldsquaw 4; eider sp. 2; murre sp. 11; Dovekie 2; Black Guillemot 9; "murres and Oldsquaw" 20; "eiders and Oldsquaw" 11.

Forty oiled birds (species unrecorded) were counted along a mile of beach at Fortune on February 22.

oiled birds found. The species mainly affected were Oldsquaws, Red-breasted Mergansers, murres, Dovekies, and Horned Grebes — all diving birds. About 80 of the 130 miles of shoreline in the Bay were affected to some degree by the oil. When beach counts were extrapolated to cover this total, the total kill must have been at least 2,300 birds. However, this is certainly an underestimate. We undoubtedly missed many birds which were covered with snow, or were so thickly coated with oil as to be unrecognizable. We must also have missed many birds which came ashore alive and crawled up off the beaches into the scrub behind; Dr. R. E. Warner (personal communication) made extensive helicopter surveys at the time of our beach counts, and found such behavior common. He also found oiled birds along the Atlantic coast outside the Bay, where the beaches were not checked. He further suggests that exposure to micro-thin oil sheens may have debilitated many birds and led to a significant but less conspicuous mortality than that caused by the slicks themselves. For these reasons, and for others discussed below, beach counts provide very inadequate indices of the bird mortality caused by oil slicks. However there is at present no way of determining the degree by which they underestimate the true figures.

TABLE 2. — Birds counted on an aerial survey of Chedabucto Bay, 15 February 1970. (Numbers over 25 are rounded off to the nearest 10.) Note that gull counts are probably underestimated.

Red-necked Grebe	1
Horned Grebe	1
Great Cormorant	4
Black Duck	170
Common Goldeneye	410
Oldsquaw	420
Common Eider	13
White-winged Scoter	7
Scoter sp.	17
Red-breasted Merganser	140
Duck sp.	40
Iceland Gull	130
Great Black-backed Gull	110
Herring Gull	460
Black-headed Gull	10
Alcid sp.	1
Bird sp.	40

Table 2 shows the results of our own aerial survey of the birds in Chedabucto Bay on February 15, after most of the oiled birds had come ashore. Most of the birds seen were flying, and so these counts certainly underestimate the numbers of grebes and alcids, which often dive at the approach of an aircraft, and are in any case hard to see from above. Comparisons with data in Table 1 are interesting. Black Ducks, a dabbling species, were little affected by the slick; surprisingly, neither were Common Goldeneyes, a common diving species in the area. However, the main concentrations of both were in parts of the Bay where there was little or no oil. The effects on Oldsquaws and Red-breasted Mergansers were obviously more serious. If one compares the aerial counts with the estimated total kills shown in Table 3, it seems possible that two-thirds of the local wintering population of each species was affected. However, this local population is relatively small, and both species are common in the Atlantic region, so it is unlikely that the oil did much damage to either species as a whole. Nor is it likely that much harm was done to murres, since these are uncommon in inshore Nova Scotian waters (Figure 3; see also Tufts 1961). We cannot assess the significance of the grebe kill; until the "Arrow" incident, there was no evidence that grebes were so common in Chedabucto Bay in winter.

(b) Sable Island

Lock made beach counts of oiled birds between March 11–13, just before Slick B reached Sable Island. He was able to cover only 1.8 miles of the 40-mile shoreline, and did not do counts on the central part of the north shore, where the oil and oiled birds were thickest. However, he sampled areas on both the north and south shores, at each end of the island. Brown rechecked these areas between May 15–25, and in all covered a total of 9.6 miles of beach. The results are shown in Table 1.

In contrast to the Chedabucto Bay situation, the great majority of dead birds were seabirds rather than ducks — in particular, murres, Dovekies, and Fulmars. The Fulmars were the only non-diving species to be killed in large

TABLE 3. — Estimated minimum mortality caused by the oil slicks. (+ indicates a significant kill for which no numerical estimate is possible.)

	Chedabucto Bay	Sable Island	Burin	St. Shotts
Grebes	450	0	A few	0
Fulmar	0	650	0	0
Oldsquaw	1000	30	+	+
Common Eider	0	0	1000	>2000 (>4000?)
Red-breasted Merganser	300	5	0	0
Murres	250	2800	1000	A few
Dovekie	100	1250	A few	0
Black Guillemot	50	50	500	+
All birds	2300	4800	3000?	>2500 (>4000?)

numbers; the oil may have caught a pack of birds sitting on the water near a fishing boat. It is clear from Table 1 that the most serious effects of the "Arrow" oil on birds occurred out at sea rather than in the Bay itself; compare the March estimate of 120 dead birds per mile on Sable Island with the 30 per mile in Chedabucto Bay. (The March estimates for Sable Island are in fact underestimates, as dead birds were already beginning to disappear from the beaches. This had gone much further by the time of the May counts. There was an average of 59 murres and 27 Dovekies per mile in March, but only 30 murres and 5 Dovekies per mile for the same beaches in May.) By extrapolation of the March totals to cover the whole island, it would appear that almost 4,800 birds were killed, including 2,700 murres, 1,250 Dovekies, and 650 Fulmars, all as the result of Slick A (Table 3).

It is very difficult to estimate the mortality caused by Slick B, because no investigation was made at the time. Almost all the birds appeared to be Common Murres, when the slick began to come ashore on March 13. This species made up 4% of the murres identified in the May counts (Table 1). If one assumes that all the Slick B murres were Common, and all the Slick A ones were Thick-billed, then there may have been as few as 100 birds killed in Slick B. But this is no more than a guess.

The origins of the murres are of some concern. There are several million pairs of Thick-billed Murres breeding in west Greenland and the Canadian Arctic, but only about 3,000–4,000 pairs in a small population breeding in Newfoundland, Labrador and the Gulf of St. Lawrence (Tuck 1961). If the Sable Island birds were from this southern population, the suggested mortality would be almost enough to wipe it out. Storer (1952) gives the parameters for geographical variation in wing and culmen length in this species; Table 4 compares these with the Sable Island birds. On both measures, the oiled birds differ significantly from those of the southern population, but do not differ at all from those breeding in the Canadian Arctic and west Greenland.

The banding evidence establishes the origin of the murres a little more closely. Tuck (1961, 1971) shows that in January and February the majority of Thick-billed Murres recovered off south and southeast Newfoundland are of west Greenland origin; birds from the Hudson Strait colonies are found mostly off eastern Newfoundland, while those from north of Baffin Island are from off west Greenland. If one assumes that the birds off Nova Scotia come from the same colonies as those off southern Newfoundland, it seems most likely that the Thick-billed Murres killed near Sable Island came from west Greenland colonies.

Similarly, the measurements of the Common Murres shown in Table 4, suggest that they came from colonies in the Gulf of St. Lawrence or Newfoundland, as opposed to the eastern

TABLE 4. — Measurements of oiled murres from Sable Island, in comparison with those from known breeding populations described by Storer (1952). (Note: probabilities (p) are calculated using t or d tests where appropriate, and refer to the significance of the difference between a given standard and the Sable Island birds.)

Thick-billed Murre	Sable Island	Gulf of St. Lawrence, Newfoundland		West Greenland, Canadian Arctic	
Wing length (mm)					
$\bar{x}$	214.8	222.4		213.8	
n	64	29		81	
Range	204–230				
s	7.40	4.85		5.25	
p		<0.001		NS*	
Culmen length (mm)		♂♂	♀♀	♂♂	♀♀
$\bar{x}$	35.43	38.50	36.59	35.67	35.32
n	67	10	17	41	31
Range	30.9–40.3				
s	2.19	1.22	2.00	1.97	2.74
p		<0.001	<0.05	NS	NS

Common Murre	Sable Island	Gulf of St. Lawrence, Newfoundland		Britain	
Wing length (mm)					
$\bar{x}$	211.7	208.1		199.4	
n	7	79		40	
Range	190–215				
s	3.24	5.20		4.70	
p		NS		<0.001	
Culmen length (mm)		♂♂	♀♀	♂♂ + ♀♀	
$\bar{x}$	44.57	44.58	43.21	47.43	
n	7	36	39	22	
Range	41.3–48.9				
s	2.50	1.74	2.40	2.25	
p		NS	NS	<0.01	

*NS — Not significant.

Atlantic. The banding data do not help to establish their origin any more closely.

The only other species that we tried to "place" in this way was the Fulmar. All the oiled birds clean enough to be examined were of the light plumage phase. Fisher (1952) notes that this is overwhelmingly the commonest phase found off Nova Scotia. Presumably, such birds are from the predominantly light-phase colonies in West Greenland and the eastern Atlantic, rather than from the dark-phase colonies in the Canadian Arctic. Banded birds from Britain and west Greenland have been recovered near Sable Island (Brown 1970). Salomonsen (1965) notes that west Greenland Fulmars have shorter bills than those from the eastern Atlantic, though there is a good deal of overlap. Brown (in preparation) measured the bills of 22 of the birds found on Sable Island; one was almost certainly a west Greenland female, and six were probably eastern Atlantic males, but the rest could not be "placed" with any certainty.

There are no absolute estimates of the numbers of seabirds wintering off Nova Scotia, so it is hard to judge the importance of the mortality resulting from these slicks. However, data collected by the Programme Intégré de Recherches sur les Oiseaux Pélagiques (PIROP) of the Université de Moncton, and by the Canadian Wildlife Service, provide a relative index of where the birds are most abundant in February and March. Figure 3 shows the average numbers of murres seen in each square ½ °N ×

1°W, during 10-min watches from moving ships; the data were collected during three cruises by Brown and four by other PIROP observers, none of them, unfortunately, in 1970. It appears that in February and March, murres are rather scarce off Nova Scotia; they are concentrated on the Grand Bank, and also close to their colonies on the Newfoundland coast. Dovekie distribution during this period is similar to that of the murres. Both of these alcids are abundant, and we doubt whether the estimated loss in the relatively unimportant part of their winter range off Nova Scotia would affect them very much. (However, we note that Thick-billed Murres are under severe pressure from hunting and salmon-netting off west Greenland (Tull *et al.* 1972), and further losses off eastern Canada could have serious consequences.)

Unpublished PIROP data show that Fulmars are generally scarce in Nova Scotian waters, and the numbers killed by Slick A were suprisingly high. In February and March Fulmars, like murres and Dovekies, are commonest on the Grand Bank Fisher 1952). Fulmars are extremely abundant and their numbers and range, at least in the eastern Atlantic, are rapidly expanding. We doubt whether the mortality caused by this slick will have much effect on the Fulmar population as a whole, though the cumulative effect of many kills of this size could, of course, be serious.

(c) Burin Peninsula and St. Shotts

The Burin Peninsula shoreline is mostly too inaccessible for standard beach counts; in his investigations, Gillespie relied on a combination of beach counts and observations from low-

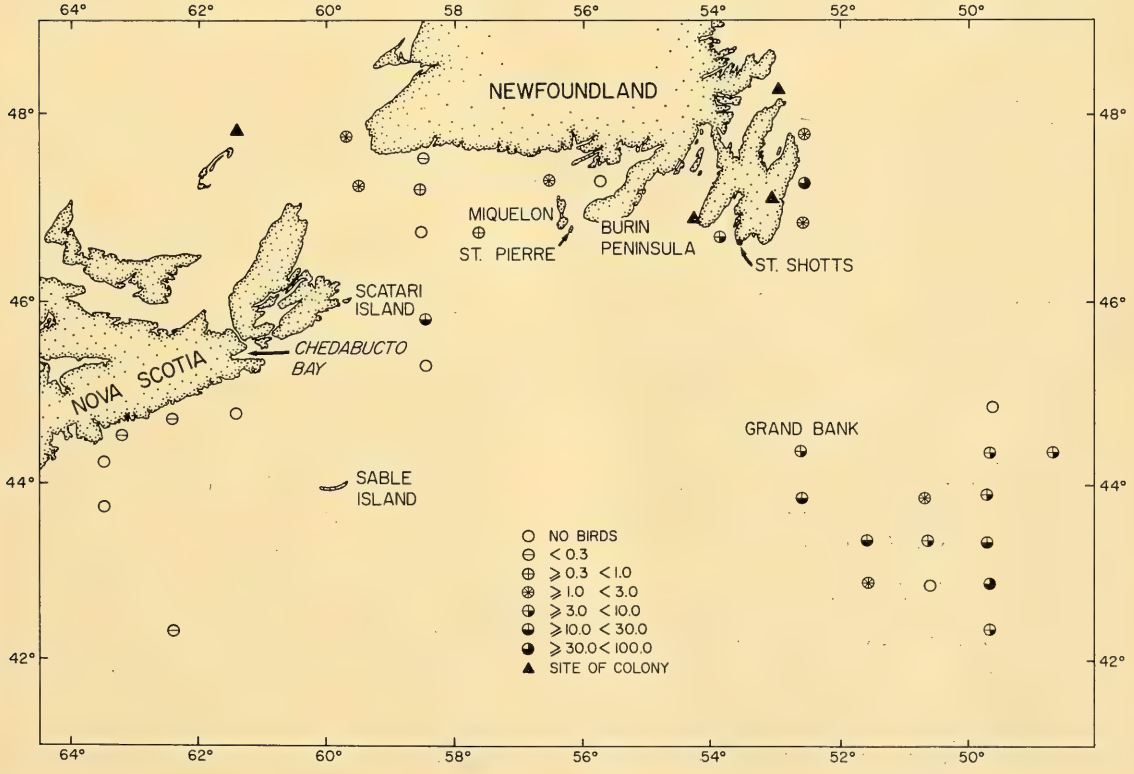

FIGURE 3. The average numbers of murres per 10-min transect seen in each ½°N × 1°W block off Nova Scotia and southern Newfoundland in February and March.

flying aircraft. On February 18 there were between 2,000–3,000 Common Eiders and several thousand alcids (murres and Black Guillemots) in the vicinity of the Burin spill. The eiders' behavior was abnormal. Birds outside the oiled area flushed when the plane was 1,000 ft above them (this is normal for healthy birds), but those in the area of the slick flushed only when the plane was low over them, and some did not flush at all. At least 2,000 eiders showed this abnormal response. It would appear that by that date a large number of the Burin birds were already debilitated through contact with the oil.

Table 1 summarizes the beach counts for the Burin area, made on February 23–24. The proportion of Common Eiders in this sample is certainly an underestimate of their total mortality, since there were no beach counts on the south shore of the Peninsula, opposite the biggest eider concentrations. An examination of oiled birds shot by hunters in this area suggested that most of the eiders caught in the slick were adult males.

Hunting was, in fact, a complicating factor in assessing mortality. Both eiders and murres are taken legally along the coast of the Province of Newfoundland at this time of year, and large numbers of lightly oiled birds were shot during the first few days after the spill. Later, however, the hunters judged the oiled birds unfit for eating, and the shooting stopped. It seems likely that the hunters were taking birds which were already dying. The increased hunting success for oiled birds provides indirect confirmation of the mortality caused by the slick.

For all of these reasons, it is very difficult to give a firm figure for the numbers of birds killed by oil off the Burin Peninsula. But probably at least 1,000–1,500 eiders died, and as many or more alcids (Table 3).

Although the oil at St. Shotts was thinner than at Burin, the kill was probably greater. Beach counts were made on March 4 and March 9–12, and are summarized in Table 1. The March 4 count covered 3 miles of beach, and produced about 500 birds; this total was not broken down into species, but it was made up mainly of Common Eiders. Extrapolation over the whole area of the spill would put the kill at about 1,500 birds up to that date .This is probably an underestimate. An aerial survey on March 2 showed that, in the St. Shotts area, there were between 6,000–10,000 eiders of which two-thirds failed to flush at the approach of the aircraft. As in the Burin Peninsula, this suggests that a large proportion of the population had already been affected by the oil. A subsequent aerial survey over part of the affected area on March 13 showed that there were at least 200 oiled eiders alive offshore.

As in the case of the Burin spill, there was a sharp increase in hunting when the oiled birds first came ashore. A survey of about half the potential hunters at St. Shotts showed that they had taken at least 200 birds between March 2–5, mainly eiders and all of them partly oiled. This, combined with the March 4 beach count and the March 13 aerial survey, indicates that a minimum of 2,000 eiders were affected by the oil. If failure to flush is accepted as evidence of oiling, then the true figure must be at least 4,000.

The remaining beach counts, on March 9–12, show the other species which were affected. (If the 500 eiders counted on March 4 are subtracted, the St. Shotts entry in Table 1 refers entirely to these later counts.) The figures certainly underestimate the numbers of Black Guillemots and Oldsquaws, which were observed to be more abundant when the slick first came ashore. The decline in murre numbers, as compared with the Burin figures, reflects a difference in habitat; murres do not feed in shoal waters like those off St. Shotts.

All the Common Eiders examined belonged to the subspecies *borealis* (which breeds in the Canadian Arctic and winters in Atlantic Canada), as opposed to *dresseri* (which breeds in Atlantic Canada and winters in New England). Gillespie's aerial surveys in February 1970 showed that there were about 50,000 of these birds along the coasts of the Burin and southern Avalon Peninsulas, and so it appears that at least 10% of this local wintering population was affected by slick D. The damage is in fact more serious than these figures suggest. In a sample of 224 eiders examined at St. Shotts,

98% were adults and 83% males. Subadult birds of any species nearly always have a higher natural mortality than adults, so that their deaths through hunting, oil, and other "artificial" causes need not, in moderation, affect the species too seriously. But this was not the case here. The predominance of males in the kill also means that a large number of females may have gone unmated in the subsequent breeding season. Gillespie's unpublished surveys indicate that the total *borealis* population numbers about 2 million birds, and so the losses described here are at most 0.5% of the whole. But 90% of this population winters in Newfoundland, and is therefore vulnerable to continuous attrition due to oil spills in its winter range. This must be even more true of *dresseri,* which is vulnerable to oil spills in Atlantic Canada in summer, and in New England in winter.

Slick D, on its drift from Burin to St. Shotts, could have had a serious effect on seabirds, since it passed close to the Common Murre colony at Cape St. Mary's, west of St. Shotts. In late February and March, murres tend to be concentrated in dense flocks on the water close to their colonies (Tuck 1961), and thus would be extremely vulnerable. Fortunately, the scarcity of murres at St. Shotts suggests that the oil missed them. Since the species of murre found at Burin was not identified, it is hard to judge the effect of the losses there; any Thick-billed Murres would probably be from the large west Greenland population (see section *b* above). Figure 3 shows that murres are quite abundant off this coast, but less so than on the Grand Bank. It is disturbing that the predicted course of the slick, after it left St. Shotts, would have taken it towards the Grand Bank.

Discussion

Throughout this paper we have emphasized that our mortality figures are underestimates, and we have given several examples of possible inaccuracy in our beach counts. This is based on the assumption that the oiled birds actually come ashore. In a case like Slick C, which did not do so, we can only compare the predicted drift with the murre distributions (Figure 1 and 3), and suggest that it probably did not do too much harm. But even when the slick reaches land, we cannot say accurately how many of the oiled birds came ashore with it. Observations in Holland (Tanis and Mörzer Bruyns 1968) suggest that as many as eight to 11 times as many oiled birds are lost at sea as come to land. Hope-Jones *et al.* (1970) put 410 dead, banded murres and Razorbills into the Irish Sea; only 82 (20%) were recovered, despite beach checks which were far more intensive than any we could manage in our investigations. They suggest that most of their missing birds sank, and in fact one of their recoveries was made a month later, in a bottom trawl net.* It would seem that estimates of mortality based on beach counts represent an unknown but perhaps quite small fraction of the true kill. Losses by sinking may not have been too great in Chedabucto Bay and southeast Newfoundland, where the oil did not drift too far before coming to shore. But they may well have biased the Sable Island estimates where Slick A, for example, took more than 3 weeks to drift from Chedabucto Bay.

In conclusion, it seems that, between them, the "Arrow" and the "Irving Whale" incidents resulted in the known deaths of about 1,500 ducks and seabirds, and that the total kill must have been at least 12,000 birds (Tables 1 and 3). By modern standards, this is rather small; three recent incidents in Britain resulted in 4,400, 10,000, and over 12,000 known deaths (Hope-Jones *et al.* 1970; Bourne *et al.* 1967; Greenwood *et al.* 1971). It is fortunate that our incidents caused relatively few deaths, and that only the kill of *borealis* eiders approaches significance to the population as a whole. This eider mortality, ironically enough, was the result of the smallest and apparently least significant of the spills. We conclude that the hazard presented by a spill depends on its position and timing as much as on its size. Moreover, because a slick moves out of sight is no indication that its hazards will disappear with it.

*We floated 12 freshly-killed murres, coated with varying amounts of Bunker C oil, in an outdoor salt-water tank on May 3 1972; all were still floating on June 5. This seems to contradict the Irish Sea data. But it is likely that wave action, or scavenging birds and fish, would make the corpses sink more quickly.

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Literature Cited

Bourne, W. R. P., J. D. Parrack and **G. R. Potts.** 1967. Birds killed in the Torrey Canyon disaster. Nature (London) 215: 1123–1125.

Brown, R. G. B. 1970. Fulmar distribution: a Canadian perspective. Ibis 112: 44–51.

Fisher, J. 1952. The Fulmar. Collins, London.

Greenwood, J. J. D., R. J. Donally, C. J. Feare, N. J. Gordon and **G. Waterston.** 1971. A massive wreck of oiled birds: northeast Britain, winter 1970. Scottish Birds 6: 235–250.

Hope-Jones, P., G. Howells, E. I. S. Rees and **J. Wilson.** 1970. Effect of "Hamilton Trader" oil on birds in the Irish Sea in May 1970. British Birds 63: 97–110.

McTaggart-Cowan, P. D., H. Sheffer and **M. A. Martin.** 1970. Task force — Operation Oil. Information Canada. Ottawa.

Salomonsen, F. 1965. The geographical variation of the Fulmar (*Fulmarus glacialis*) and the zones of marine environment in the North Atlantic. Auk 82: 327–355.

Smith, J. E. (Editor). 1968. Torrey Canyon pollution and marine life. Cambridge University Press, Cambridge.

Storer, R. W. 1952. A comparison of variation, behaviour and evolution in the sea bird genera. *Uria* and *Cepphus*. University of California Publications in Zoology 52: 121–122.

Tanis, J. J. C. and **M. F. Mörzer Bruyns.** 1968. The impact of oil pollution on seabirds in Europe. Proceedings of International Conference on Oil Pollution of the Sea, 7–9 October, 1968, at Rome. pp. 69–74.

Tuck, L. M. 1961. The Murres. Department of Northern Affairs and National Resources, Canadian Wildlife Service, Canadian Wildlife Series: 1. Ottawa.

Tuck, L. M. 1971. The occurrence of Greenland and European birds in Newfoundland. Birds Banding 42: 184–209.

Tull, C. E., P. Germain and **A. W. May.** 1972. Mortality of Thick-billed Murres in the west Greenland salmon fishery. Nature (London) 237: 42–44.

Tufts, R. W. 1961. The birds of Nova Scotia. Nova Scotia Museum. Halifax.

Scientific Names of Species Mentioned in the Text

Common Loon	*Gavia immer*
Red-necked Grebe	*Podiceps grisegena*
Horned Grebe	*Podiceps auritus*
Fulmar	*Fulmarus glacialis*
Leach's Petrel	*Oceanodroma leucorhoa*
Gannet	*Morus bassanus*
Great Cormorant	*Phalacrocorax carbo*
Black Duck	*Anas rubripes*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Oldsquaw	*Clangula hyemalis*
Common Eider	*Somateria mollissima*
King Eider	*Somateria spectabilis*
White-winged Scoter	*Melanitta deglandi*
Red-breasted Merganser	*Mergus serrator*
Iceland Gull	*Larus glaucoides*
Great Black-backed Gull	*Larus marinus*
Herring Gull	*Larus argentatus*
Black-headed Gull	*Larus ridibundus*
Razorbill	*Alca torda*
Common Murre	*Uria aalge*
Thick-billed Murre	*Uria lomvia*
Dovekie	*Plautus alle*
Black Guillemot	*Cepphus grylle*
Common Puffin	*Fratercula arctica*

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North American Nonparasitic Lampreys of the Family Petromyzonidae Must Be Protected

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Vladykov, V. D. 1973. North American nonparasitic lampreys of the family Petromyzonidae must be protected. Canadian Field-Naturalist 87: 235-239.

Abstract. There are nine nonparasitic species of lampreys in five of the six North American genera. This paper gives ecological, economic, and ethical reasons why it is important that the nonparasitic lampreys must be conserved, and recommends urgent protection for the habitats of endangered species of the genus *Lampetra,* especially in California and Maryland.

Introduction

McAllister (1970) listed rare or endangered Canadian fishes other than lampreys. Bond (1966) and Shay (1973) mentioned both types, nonparasitic and parasitic, of Pacific lampreys of the genus *Entosphenus* among "endangered species" of Oregon. Miller (1972) mentioned several species of lampreys as "threatened fishes of the United States." The purpose of the present article is to recommend protection for all species of nonparasitic lampreys described from the North American continent.

According to Vladykov and Follett (1967), six genera of lampreys are found in Canada, the United States, and Mexico. With the sole exception of *Petromyzon* Linnaeus, 1758, one or more nonparasitic species, in addition to the parasitic species have been established in each genus. The different genera have the following number of nonparasitic species: *Ichthyomyzon* and *Lampetra,* three each; *Entosphenus, Tetrapleurodon,* and *Lethenteron,* one each. The definition of parasitic and nonparasitic habits of lampreys may be found in Hubbs and Trautman (1937) and Vladykov (1949, 1972).

In contrast to the parasitic species, nonparasitic lampreys are not migratory in habit, and spend their entire life in small brooks. Several species have a very restricted area of distribution. Moreover, the reproductive capacity of nonparasitic species, typically of smaller size, is limited. For instance, *Lethenteron lamottei* sheds on the average 2,339 eggs and *Ichthyomyzon fossor* only 1,524. In contrast, parasitic lampreys are much larger in size and are many times more prolific: landlocked *Petromyzon marinus* in the Great Lakes lays on the average 60,000 eggs and anadromous specimens can produce 171,600 eggs (Vladykov 1951).

There are two principal causes for the reduction in the number of nonparasitic lampreys: (*a*) unfavorable manipulation of the environment by man; and (*b*) in the Great Lakes region, they are being destroyed inadvertently in an attempt to exterminate the parasitic *P. marinus* by using lamprey larvicides.

List of Nonparasitic Species

The names and broad distribution of nonparasitic species already described are as follows.

I. ICHTHYOMYZON Girard, 1858

1. *I. fossor* Reighard & Cummings, 1916 — Northern Brook lamprey. Found through the Great Lakes to the St. Lawrence River drainage, and possibly in the western tributaries of the Hudson Bay.
2. *I. gagei* Hubbs & Trautman, 1937 — Southern Brook lamprey. Distributed from Iowa, northern Wisconsin to the Alabama River system.
3. *I. greeleyi* Hubbs & Trautman, 1937 — Allegheny Brook lamprey. Found in the Ohio River, including the Wabash and Tennessee Rivers; Ohio, Kentucky, Illinois, Indiana, Tennessee, Alabama, Virginia, and North Carolina. I consider *I. hubbsi* Raney, 1952, to be synonymous with *I. greeleyi.*

II. ENTOSPHENUS Gill, 1863

4. *E. lethophaga* (Hubbs 1971) — Klamath Brook lamprey. Described from northeast California and the upper Klamath River system in southcentral Oregon.

III. TETRAPLEURODON Creaser & Hubbs, 1922

5. *T. geminis* Alvarez, 1966 — Nonparasitic Mexican lamprey. Reported from Rio Celio en Jacona, 10 km east of Morelia, Michoacán, Mexico.

IV. LETHENTERON Creaser & Hubbs, 1922

6. *L. lamottei* (or *lamottenii*) (Lesueur 1827) — American Brook lamprey. Distributed in freshwater sections of the Mississippi River, Great Lakes, and St. Lawrence River basin; possibly the same species is present in the Yukon River system of Alaska.

V. LAMPETRA Gray, 1851

7. *L. richardsoni* Vladykov & Follett, 1965 — Western Brook lamprey. Found in rivers of the Pacific drainage of North America in British Columbia, Washington, and Oregon.
8. *L. pacifica* Vladykov, 1973 — Pacific Brook lamprey. Distributed in freshwater streams of Oregon and California.
9. *L. aepyptera* (Abbott 1860) — Least Brook lamprey. Found in Maryland, Virginia, North Carolina, and Ohio.

Discussion

Why should nonparasitic lampreys be protected? There are numerous reasons for it, but only the important considerations shall be presented.

In dealing with any living organism, especially less common ones, consideration should be given to protect it from extinction. "Conservationists tend to take for granted that rare species ought to be saved . . . There are in fact four main groups of reasons why we should conserve the natural world, and guard against the generality of common species becoming rare, let alone the rare ones becoming extinct. They have been well summarised by Elspeth Huxley, writing for the World Wildlife Fund, as the Four Pillars of Conservation: Ethical, Aesthetic, Scientific and Economic. The Ethical Pillar recognises that man is a part of the natural world, that he cannot separate himself from it without losing an important part of his own heritage, and that every needless or avoidable destruction of his fellow creatures is in some sense a derogation from human dignity" (Fitter 1968, pp. 18–19). The meaning of the other Pillars is self-explanatory.

Importance of Ammocoetes

1. A large concentration of ammocoetes in a brook is very favorable to its ecosystem. Through a ring of oral cirrhi, ammocoetes of any species feed on diatoms and other minute organisms by straining them from the water (Hardisty and Potter 1971a; Poltorykhina 1971). These organisms help the body building of an ammocoete; they would otherwise not be utilized by other vertebrates found in the brooks. In the food chain of a brook, ammocoetes themselves constitute a natural food for many valuable fishes such as rainbow trout, smallmouth bass, pickerel (Vladykov 1949), eel (Perlmutter 1951), and pike, and for herring gulls (McPhail and Lindsey 1970).

2. In many areas of North America, ammocoetes are used as fish bait. In Quebec, ammocoetes, principally *L. lamottei,* are sold to catch pickerel (*Stizostedion vitreum*), muskellunge (*Esox masquinongy*), and other sport species. During 1947 and 1948 around Lake St. Peter and St. Anne-de-la-Pérade, ammocoetes were dug from mud banks and sold as bait from $0.50 to $1.00 per dozen. To our knowledge, two local men in 1947 sold at least 8,000 dozens of ammocoetes for the total amount of $4,000 (Vladykov 1949). During the same period, in the St. Maurice River near St-Roch-de-Mékinac, Quebec, the annual sale of *lamottei* ammocoetes was about 200,000 individuals (Vladykov 1952).

According to Schultze (1930), in western sections of Washington, ammocoetes of *Lampetra planeri,* known today as *L. richardsoni* (Vladykov and Follett 1965), were collected in great numbers as bait for bass and trout fishing and sold for $1.50 or $1.75 per dozen.

3. Moore and Beamish (1973) found that the food composition, principally diatoms, of ammocoetes of *Petromyzon marinus* and *Lethenteron lamottei* is the same. These observations give additional weight to the conviction of the present author (Vladykov 1972) that the ammocoetes of *L. lamottei,* which are larger than those of *P. marinus,* should be used for the "biological control" of the latter species. By bringing in an additional supply of *lamottei* ammocoetes, a natural competition might be furthered for food among the ammocoetes of parasitic and nonparasitic species living in the same brook.

The proposed biological control would replace larvicides such as TFM (3-trifluoromethyl-4-nitrophenol), which is still in use for the control of sea lampreys (Lawrie 1970). It should be added that larvicides are harmful also to other fishes (Manion 1969; Smith and King 1970) and to some aquatic invertebrates (Smith 1967).

Assisting at the application of larvicides for the extermination of ammocoetes in a stream, one is awed by the enormous number not only of *P. marinus* but also of other species, particularly *L. lamottei,* that are killed. Manion and Purvis (1971) mentioned that personnel of the U.S. Fish and Wildlife Service in 1950–1970 obtained and examined an estimated two millon specimens of *L. lamottei.* After such a mass extermination, the ecosystem of the respective streams becomes almost certainly unbalanced. Unfortunately, no detailed study has been made on this subject. However, an interesting report was made by Smith and McLain (1962) on the number of ammocoetes present in the Ogontz River, a small spring-fed tributary to northern Lake Michigan in Delta County, Michigan. They estimated the total population of ammocoetes to be 336,724 individuals, about equally divided between *L. lamottei* and *P. marinus.*

Hardisty and Potter (1971a) stated that "because of the concealed habit of larval lampreys, their numbers and widespread distribution have not been fully appreciated, while the significance of their role in the ecology of river systems has been almost completely ignored."

Importance of Adult Lampreys

1. Hardisty and Potter (1971b) devoted considerable attention to "paired species" among lampreys. The term "paired species" is applied to pairs of closely related lampreys, of which one is a nonparasitic or brook lamprey and the other a parasitic species similar to the form from which the nonparasitic species has probably been derived. In reality, among "paired species" of lampreys, not two but often three species are found, all of which are closely related to one another. To clarify this interrelation, additional studies of nonparasitic lampreys in different stages of their development would be highly important. It should be added also that in North America, there exist several species of nonparasitic lampreys, particularly in the genera *Lampetra* and *Entosphenus,* that are not described as yet.

The existence of several species of nonparasitic lampreys is a very important factor in nature conservation as "the species is not only the basic unit of classification, but also one of the most important units of interaction in ecology and ethology" (Mayr 1963, p. 11).

2. The transformed nonparasitic lampreys are very easy to keep in aquaria as they do not require any feeding, and could conveniently be used as experimental animals.

3. Since nonparasitic lampreys in all stages of development are not harmful to man, they should be protected. It should be remembered that "conservation is basically the maintenance of the flow of energy through the habitat to be conserved . . . Its prime aim is to maintain the variety of species and the web of their interrelationships, for each animal and plant specialises in converting energy at some stage of the food chain, even if its specialism is to be more or less omnivorous" (Fitter 1968).

Destruction of Nonparasitic Lamprey Habitats

Because of unwise manipulation of the environment by man, the typical habitats of nonparasitic lampreys, particularly of the genera *Lethenteron* and *Lampetra,* are being drastically altered and in some cases, even made uninhabitable.

The Great Lakes Region. Widespread use of lamprey larvicides such as TFM intended to exterminate the ammocoetes of *P. marinus,* inadvertently destroy large numbers of ammocoetes of nonparasitic lampreys, particularly those of *Lethenteron lamottei.*

Ohio. According to Trautman (1957, p. 147), "between 1925–50 there was a general decrease in abundance of the Ohio Brook Lamprey (*Lampetra aepyptera*) in this state, and during that period populations in many streams were extirpated. This decrease was caused by destruction of lamprey habitats and by the ever in-

creasing demand for both adults and ammocoetes as bait."

Maryland. Seversmith (1953) was able to collect good samples of *L. aepyptera* in two tributaries of the Patuxent River, Maryland, in 1950–1952. He wrote that "both brooks appear to be free of pollution in the area explored; algae, protozoa and insect larvae are found in abundance." At the present, conditions are very different and apparently *L. aepyptera,* the smallest species of American lampreys, is becoming very rare. I have asked several Maryland biologists to obtain this species for me, but to no avail.

California. There are several species of nonparasitic lampreys of the genera *Entosphenus* and *Lampetra.* In addition to the described species (Hubbs 1971; Vladykov 1973), there are at least two interesting undescribed forms of *Lampetra,* one of which is found in Garcia River, Mendocino County, while the other is known from Coyote Creek, Santa Clara County (Vladykov 1973). In Coyote Creek, located in the San Francisco Bay area, many nonparasitic *Lampetra* were collected in 1922–1924 by C. L. Hubbs (1925), around 1930 by L. P. Schultz (1930), and by W. I. Follett (in letter June 4, 1972), who wrote that in 1932, in the lower part of Coyote Creek, several species of fishes and lampreys were collected by him. But in May 1972, "the stream has now been devastated: dammed, drag-lined, channeled, and possibly poisoned. I did not see a fish of any kind, nor did I collect or see a lamprey."

Recommendations

On the basis of the facts presented in the preceding text, the following recommendations are warranted.

1. All North American nonparasitic lampreys should be considered as "endangered species," and necessary measures for the protection of their habitat should be taken as soon as possible. The most threatened areas are found in California and Maryland.

2. For the Great Lakes region, it is urgently requested that the use of lamprey larvicides be stopped completely, or at least used only in most urgent situations. Instead of larvicides, the use of a possible "biological control" of *P. marinus* ammocoetes by *L. lamottei* ammocoetes as a competitive species for food is recommended.

In conclusion, it should be repeated with McAllister (1970) that "our fish fauna is part of our natural heritage which we wish to pass on to future generations to see and to enjoy."

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Literature Cited

Alvarez del Villar, J. 1966. Ictiología michoacana. IV. Contribución al conocimiento biológico y sistemático de las lampreas de Jacona, Mich., México. Anales de la Escuela Nacionál de Ciencias Biológicas. 13 (1–4): 107–144.

Bond, C. E. 1966. I. Fishes. *In* Endangered plants and animals of Oregon. Agricultural Experiment Station, Oregon State University, Corvallis, Oregon. pp. 1–8.

Fitter, R. 1968. Vanishing wild animals of the world. Franklin Watts, Inc., New York.

Hardisty, M. W. and **I. C. Potter.** 1971a. The behaviour, ecology and growth of larval lampreys. *In* The biology of lampreys. *Edited by* M. W. Hardisty and I. C. Potter. Academic Press, Inc., London. pp. 249–277.

Hardisty, M. W. and **I. C. Potter.** 1971b. Paired species. *In* The biology of lampreys. *Edited by* M. W. Hardisty and I. C. Potter. Academic Press, Inc., London. pp. 85–125.

Hubbs, C. L. 1925. The life-cycle and growth of lampreys. Papers of the Michigan Academy of Sciences, Arts and Letters 4: 587–603.

Hubbs, C. L. 1971. *Lampetra* (*Entosphenus*) *lethophaga,* new species, the nonparasitic derivative of the Pacific lamprey. Transactions of the San Diego Society of Natural History 16: 125–163.

Hubbs, C. L. and **M. B. Trautman.** 1937. A revision of the lamprey genus *Ichthyomyzon.* University of Michigan, Museum of Zoology Miscellaneous Publications 35: 7–113.

Lawrie, A. H. 1970. The sea lamprey in the Great Lakes. Transactions of the American Fisheries Society 99: 766–775.

Manion, P. J. 1969. Evaluation of lamprey larvicides in the Big Garlic River and Saux Head Lake. Journal of the Fisheries Research Board of Canada 26: 3077–3082.

Manion, P. J. and **H. A. Purvis.** 1971. Giant American brook lampreys, *Lampetra lamottei,* in the

upper Great Lakes. Journal of the Fisheries Research Board of Canada 28: 616–620.

Mayr, E. 1963. Animal species and evolution. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. xiv + 797 pp.

McAllister, D. E. 1970. Rare or endangered Canadian fishes. Canadian Field-Naturalist 84: 5–8.

McPhail, J. D. and **C. C. Lindsey.** 1970. Freshwater fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173. 381 pp.

Miller, R. R. 1972. Threatened Fishes of the United States. Transactions of the American Fisheries Society 101: 239–252.

Moore, J. W. and **F. W. H. Beamish.** 1973. Food of larval sea lamprey (*Petromyzon marinus*) and American brook lamprey (*Lampetra lamottei*). Journal of the Fisheries Research Board of Canada 30: 7–15.

Perlmutter, A. 1951. An aquarium experiment on the American eel as a predator of larval lampreys. Copeia 1951: 173–174.

Poltorykhina, A. N. 1971. Metamorphosis of the Arctic brook lamprey (*Lampetra japonica kessleri* (Anikin)) in the Upper Irtysh. Journal of Ichthyology 11: 281–285.

Raney, E. C. 1952. A new lamprey, *Ichthyomyzon hubbsi,* from the upper Tennessee River system. Copeia 1952: 95–99.

Schultze, L. P. 1930. The life history of *Lampetra planeri* Bloch, with a statistical analysis of the rate of growth of the larvae from western Washington. University of Michigan, Museum of Zoology, Occasional Papers No. 221: 1–35.

Seversmith, H. F. 1953. Distribution, morphology and life history of *Lampetra aepyptera,* a brook lamprey, in Maryland. Copeia 1953: 225–232.

Shay, R. 1973. Oregon's rare or endangered wildlife. Oregon State Game Commission Bulletin 29: 1–12.

Smith, A. J. 1967. The effect of the lamprey larvicide, 3-trifluoromethyl-4-nitrophenol, on selected aquatic invertebrates. Transactions of the American Fisheries Society 96: 410–413.

Smith, B. R. and **E. L. King, Jr.** 1970. Lamprey control in the United States. Great Lakes Fishery Commission, Annual Report for 1969: 29–40.

Smith, B. R. and **A. L. McLain.** 1962. Estimation of the brook and sea lamprey ammocoete populations of three streams. Great Lakes Fishery Commission Technical Report No. 4: 1–26.

Trautman, M. B. 1957. The fishes of Ohio. The Ohio State University Press. xv + 683 pp.

Vladykov, V. D. 1949. Quebec lampreys. 1. List of species and their economic importance. Department of Fisheries, Province of Quebec. Contribution No. 26: 1–67.

Vladykov, V. D. 1951. Fecundity of Quebec lampreys. Canadian Fish Culturist 10: 1–14.

Vladykov, V. D. 1952. Distribution des lamproies (Petromyzonidae) dans la Province de Québec. Naturaliste Canadien 79: 85–120.

Vladykov, V. D. 1972. Lampreys of the Ottawa area. Trail and Landscape 6: 121–128.

Vladykov, V. D. 1973. *Lampetra pacifica,* a new nonparasitic species of lamprey (Petromyzonidae) from Oregon and California. Journal of the Fisheries Research Board of Canada 30: 205–213.

Vladykov, V. D. and **W. I. Follett.** 1965. *Lampetra richardsoni,* a new nonparasitic species of lamprey (Petromyzonidae) from western North America. Journal of the Fisheries Research Board of Canada 22: 139–158.

Vladykov, V. D. and **W. I. Follett.** 1967. The teeth of lampreys (Petromyzonidae): their terminology and use in a key to the Holarctic genera. Journal of the Fisheries Research Board of Canada 24: 1067–1075.

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Plant Communities North of the Forest Border, Keewatin, Northwest Territories

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Larsen, J. A. 1973. Plant communities north of the forest border, Keewatin, Northwest Territories. Canadian Field-Naturalist 87: 241-248.

Abstract. The vegetation of the ecotone region which extends from the forest border at the south end of Ennadai Lake northward to Dubawnt Lake, some 150 miles distant, is characterized by floristically depauperate communities in the region immediately adjacent to the forest border and by an increasing number of typically arctic species northward. Decreasing frequency northward of atmospheric conditions related to the arctic frontal zone (and, hence, increasing frequency of occurrence of arctic air masses) is associated with increasing presence of arctic species. It appears possible to define the extent of this climatic transition zone on the basis of the structure of the plant communities of the area. The existence of such a zone of depauperate plant communities correlated with a climatic zone invites speculation as to the causal relationships involved.

Introduction

In the vast northern interior plains of Canada, the transition zone between forest and tundra, caled variously the continental arctic tree line, the northern forest border, or the northern forest–tundra ecotone, lies roughly along a WNW–ESE axis extending from the Mackenzie Delta in the northwest to the western shore of Hudson Bay at the mouth of the Churchill River. Along this entire length, the forest border swings northward at some points, southward at others, forming interdigitations of forest-into-tundra along river valleys, tundra-into-forest along expanses of uplands, and between these extremes there are the ubiquitous lichen woodlands — forests of widely spaced spruces with a ground carpet of lichens, scattered northern shrubs, and individuals of a number of common herbaceous species.

This striking geographical zonation in the vegetation is coincident with the pathway of cyclonic storms along the average summer position of the arctic front, a climatic zone separating arctic air masses prevailing over the tundra of northern arctic Canada from the air masses of southern origin prevailing over the subarctic vegetation of spruces and treed muskeg (Bryson 1966). The coincidence of these two transition zones, the one climatic and the other vegetational, has been the subject of a recent publication (Larsen 1971b), the details of which need not be repeated here. It was demonstrated, however, that not only does the northern edge of continuous forest coincide with this climatic frontal zone but there are also marked changes across this zone in the frequency counts of species making up the ground or understory vegetation. Climatic variation across the boundary between the two regions is sufficient to account, at least in large measure, for the equally marked vegetational differences since geological and topographical characteristics are generally uniform throughout (Lee 1959). The interesting point to be explored here is that there exists a zone of relatively depauperate vegetational communities just north of the forest border in central and southwestern Keewatin and that these communities apparently identify a climatic zone possessing rather definite and identifiable characteristics.

Previous Studies

Previous vegetational studies have been conducted in the forest–tundra ecotone in the regions around Ennadai and Artillery Lakes, Keewatin and Mackenzie, N.W.T., central Canada, and in northern Keewatin (Larsen 1965, 1971a, 1971b, 1972a, 1972b, 1972c). These studies reveal that the tundra communities here are floristically depauperate, characterized by

fewer plant species than communities either north or south of this transition zone. Moreover, species making up the transition zone communities are geographically wide ranging, many occupying habitats throughout both the northern edge of the forest and the low arctic tundra. While these species, in aggregation, may be said to characterize the tundra communities of the regions, many are so ubiquitous throughout both forest and tundra (Larsen 1971b) that their ecological relationships, particularly those involving climatic conditions, pose some interesting and perplexing problems.

There are some rather definite relationships between forest border and regional climatic characteristics (Larsen 1965). The zone of floristically depauperate tundra communities extends for some distance north of the forest border, and it appears that this distinct vegetational zone coincides with a correspondingly distinct climatic zone. Frontal conditions obviously prevail with greatest frequency along the mean frontal position and they occur with decreasing frequency northward and southward of this position. Plant species adapted to survival in the region dominated by arctic masses would be expected to occur with increasing presence, frequency, or both, in vegetational communities along a traverse from forest into the region occupied nearly continuously by arctic air. Apparently it can be inferred from the remarkable width of the transition zone characterized by depauperate vegetational communities that the climatic frontal conditions in Keewatin occupy a broader north–south band than they do farther to the west.

Methods

During the summer field season of 1963, a traverse by canoe was run along the Kazan River from Ennadai Lake northward to the west end of Angikuni Lake, thence up a small river to an unnamed lake (62° 22′N, 100° 32′W). From here, camp was moved to Dubawnt Lake. Sampling of vegetational communities was carried on at various points along the traverse from Ennadai to Angikuni and again at Dubawnt. Data from this sampling are employed here, as well as data obtained during previous visits to Ennadai and Dubawnt Lakes (Larsen 1965), and during the 1966 field season, at Pelly Lake, Snow Bunting Lake, and Curtis Lake (Larsen 1972a, 1972b, 1972c). A map of the region showing the study areas is presented in Figure 1.

The sampling technique was the same as that employed in studies cited above. Since local variation in species composition and species frequency in plant communities of the region appears to be closely correlated with topographical position, communities for sampling were selected on the basis of general topographical site. These are designated as follows: (1) rock field — communities occupying the summits of the low, rolling, rocky hills of glacial drift found throughout the region; (2) tussock muskeg — communities usually occurring on sites intermediate between the rock fields and wet meadows, often underlain by shallow turfy accumulations of roots, plant detritus, and peat; (3) low wet *Carex* meadow — communities occupying shallow depressions in the terrain, inundated in spring and often quite wet throughout the summer, containing a considerable accumulation of plant detritus and wet peat beneath the surface carpet of living plants in which *Carex* species constitute a major component.

Sampling was carried on within each of these three sites at all study areas where they were available (tussock muskeg is rare in the most northern study areas), and additionally, in one other community when the opportunity existed, a community dominated by dwarfed black spruce (*Picea mariana*). The sampling procedure consisted of obtaining species frequencies in transects of 20-m^2 quadrats, located 10 paces apart along a compass line through the sampled community. Replication in each of the study areas was achieved by running as many transects as possible in each community type, but on different sites. The principal sampling areas along the traverse from which data used in this study have been obtained are as follows:

1. south end of Ennadai Lake (60°40′N, 101°40′W);

FIGURE. 1. Map of Keewatin showing the study areas mentioned (and numbers referred to) in the text.

2. north end of Ennadai Lake (61°10′N, 100°50′W);
3. Kazan River (61°22′N, 100°38′W);
4. Kazan River (61°29′N, 100°28′W);
5. Kazan River (61°42′N, 100°38′W);
6. Kazan River (61°48′N, 100°40′W);
7. Kazan River (61°57′N, 100°48′W);
8. Kazan River (62°00′N, 100°46′W);
9. Kazan River (tributary) (62°21′N, 100°33′W);
10. Dubawnt Lake (62°43′N, 101°43′W);
11. Pelly Lake (66°03′N, 101°03′W);
12. Snow Bunting Lake (66°10′N, 94°25′W);
13. Curtis Lake (66°50′N, 88°55′W);

The numbers assigned to the areas are those employed in the summary table (Table 1).

TABLE 1. — Numbers of species in the communities at the various study sites. Numbers in the study area row identify the sites listed in the text, and the progression is (left to right) from south to north.

Tussock muskeg communities (data is for individual stands sampled)																				
Study area	2	2	2	2	2	2	2	2	2	2	3	8	10	10	10	10	10			
Total species	16	14	13	11	9	10	10	10	7	10	18	23	27	27	20	31	29			
Total arctic species	2	1	0	0	0	0	0	0	0	0	4	11	17	15	14	20	21			
Rock field communities																				
Study area	2	2	2	2	2	2	4	5	6	7	9	10	10	11	11	11	12	12	13	13
Total species	7	9	9	9	9	11	8	11	15	20	14	20	21	14	13	14	12	13	13	15
Total arctic species	2	4	4	4	4	6	4	6	10	15	9	15	16	11	9	11	11	11	13	13
Low meadow communities																				
Study area	2	2	2	2	2	2	2	2	2	4	7	8	10	10	11	11				
Total species	13	11	10	14	11	10	13	14	12	12	15	13	17	18	18	20				
Total arctic species	2	1	1	3	1	1	2	2	2	3	4	2	3	9	7	5				
Dwarfed spruce communities																				
Study area		1		1		1		1		2		2		7		10				
Total species		22		10		11		18		23		12		15		24				
Total arctic species		3		3		2		4		7		5		5		10				

Results

A northward increase in total number of species represented in the tundra communities sampled along the traverse is revealed in the accompanying summary Table 1 (a complete set of tabular data concerning the species frequency in stands along a south-north traverse in the four communities is available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada K1A 0S2). The dwarfed black spruce communities sampled show a change in species composition and frequency along the traverse but there appears to be no significant change in species numbers. The species which begin to appear more commonly in the associations toward the northern end of the traverse are species more generally arctic in geographical affinity. They are absent, or present only very rarely, in the plant communities at the southern end of the traverse and hence are missed in sampling.

Frequency values of the arctic species can also be seen to increase northward, in general, although frequency values for some species at first rise northward and then decline again.

The ubiquitous species (foremost in the listings) usually maintain high frequency values throughout the traverse, although frequency values may decline at the northernmost study areas as the data from Pelly, Snow Bunting, and Curtis Lakes reveal. Some disappear altogether from the communities in the latitudinally higher and climatically more arctic areas.

The species categorized as ubiquitous on the basis of their widespread appearance in the transect data of both forest and tundra study areas include *Vaccinium vitis idaea, V. uliginosum, Betula glandulosa, Empetrum nigrum,* and *Rubus chamaemorus.* Among the species categorized as arctic in affinities are *Arctostaphylos* (*Arctous*) *alpina, Ledum decumbens, Dryas integrifolia, Cassiope tetragona, Diapensia lapponica, Salix arctica, Oxytropis arctica,* and *Polygonum viviparum.* For a more complete listing see the previous publications cited above and the data on file in the NRC Depository of Unpublished Data.

It should be noted that in the tables the term *"Carex* sp/spp." refers to presence of any or all species of *Carex.* Many species at a given time are without fruiting heads; hence, the actual frequency of a named *Carex* species is very likely higher than the value given, since non-fruiting individuals probably were present in additional quadrats. The *"Carex rotundata* group" refers to an aggregation of *Carex rotundata, C. saxatilis, C. membranaceae,* and *C. physocarpa,* differentiation of which is difficult in the field. Specimens collected, however, in-

dicate that a large percentage can be attributed to *C. rotundata.*

Discussion

If it can be assumed that plant species native to the Arctic and Subarctic have rather well-defined environmental tolerances, then it is reasonable to infer that the response shown by species appearing in the communities sampled is a response to climate, since topography, surficial geology, and parent materials are quite similar throughout the region, which is classified as a single geographical province (Bostock 1964). Since species occurring just north of the forest border at Ennadai Lake generally are ubiquitous species, and since arctic species occur in increasing numbers and with increasing frequency values northward toward Dubawnt and Pelly, Snow Bunting, and Curtis Lakes, it is postulated that this represents a response to climatic conditions prevailing in the region. It is, of course, inferred that climatic conditions become increasingly "Arctic" northward owing to increasing frequency of occurrence of air masses characteristic of, and originating in, the northern regions.

Absence of weather data for areas immediately north and south of the Ennadai Aeradio station makes it impossible to compare the frequency of occurrence of air masses of various types at points between Ennadai and Dubawnt Lakes, or for areas northward and southward of these points, but it can be inferred that toward Dubawnt the influx of air of more southerly origin occurs at relatively more rare intervals, sufficiently rare, in fact, to contribute, to a much lesser extent than arctic air, to the environmental conditions to which plant life is subjected. It is conceivable that this assumption could be verified by establishing automatic weather recording stations at points between Ennadai and Dubawnt for a month or two during the summer season.

No quantitative work has been conducted to determine whether a corresponding floristically depauperate zone can be discerned in the vegetational communities for a comparable distance south of the forest border, although perhaps the concept is inherent or at least vaguely implied in the traditional idea of taiga. Studies by Argus (1966) in northeastern Saskatchewan, less than 80 miles to the southwest of the forest border at Ennadai Lake, reveal the presence of many species which do not occur, at least abundantly, in the Ennadai communities. Argus presents no quantitative community data, but it would appear that these northeastern Saskatchewan communities are relatively rich in boreal species. This lends some credence to the possibility that a zonation to the south of the forest border will be found, one which corresponds to the increasing richness of arctic species in the zone to the north of the forest.

It is of some interest that trees identified in the field as white spruce (*Picea glauca*) occur abundantly on some sites, both on eskers and along small streams running through draws between hills, both at Ennadai (Larsen 1965) and in other areas at or near the forest border in central Canada (Ritchie 1959) and eastern Canada (Hustich 1966), but not in the area studied by Argus some distance southwest of the forest border. Dwarfed white spruce, identified by cone size and shape, have been photographed by the author on the shore of Dubawnt Lake, and rather tall specimens of what were identified in the field as white spruce, additionally, have been found on eskers 25–30 miles north of Ennadai Lake along the Kazan River, as well as at a point just west of Yathkyed Lake (62°44′N, 98°38′W). Similarly, white spruce also is found north of the forest border along the shores of Artillery Lake. These outliers of a species, with apparently more restricted environmental tolerances than black spruce, pose interesting ecological, and perhaps paleoclimatological, questions, as well as genetic ones, since what appears to be evidence of introgression between black and white spruce also occurs here.

Spruce stands found north of the forest border presumably represent relicts surviving from a period when the border lay farther north than it does at the present time (Nichols 1967). Small clumps of black spruce, probably clones since reproduction appears to be primarily by layering, thus constitute a potential source of propagules for afforestation of the entire area,

and the question arises as to the characteristics of either the environment or of spruce, or of both, which prevent the spread of spruce forest over most of the available land surface.

Climatic effects may be sufficient to accomplish the remarkable transformation in the character of the vegetation which has been demonstrated to occur over this relatively short distance, from south of the average frontal position of the arctic air mass to north of it. On the other hand, some self-perpetuating system which augments the influence of the climatic parameters may be at work within the forest or the forest-environment complex, although the presence of such a system is not at present recognized, nor understood if it indeed exists. A comparison of the radiation characteristics and energy budgets of forest and tundra has revealed differences of sufficient magnitude to warrant further study of the possibility that energy relationships on a gross forest-atmosphere scale are involved (Hare and Ritchie 1972).

It is possible, however, that energy transfer relationships within the forest itself effectively contribute to maintenance of the forest where it now exists. The forest canopy undoubtedly serves as both windbreak and energy trap, resulting in higher soil- and ground-level air temperatures in the forest than will occur in tundra, even when air temperatures at some short distance above forest and tundra vegetation are identical. Hence, the closed forest canopy tends to create a ground-level environment more ameliorated in terms of growing conditions for mesophytic plants than that to which tundra vegetation is exposed, even on adjacent and similar topographic sites. Species comprising the spruce understory community are obviously capable of survival and reproduction in the forest environment, but many are equally obviously unable to advance into areas occupied by tundra. Even very small environmental differences must be critical, and these must account for the abrupt nature of the forest border.

The active layer of soil appears to be deeper, and hence summer soil-surface temperatures higher, under the more closed-canopied spruce forest at the south end of Ennadai than under the small, isolated dwarfed spruce clumps at the north end (Larsen 1965). Persistence of permafrost at shallow depths appears to render the environment a marginal one for spruce in these latter clumps, and permafrost levels may account for the failure of spruce clumps to regenerate after disturbance. The traditional concepts of forest succession must be inapplicable at the forest border since, once forest has been eliminated, there appear to be no species, or aggregations of species, capable of ultimately creating conditions which will again permit ecesis by spruce and the spruce community, unless a change in climate has ameliorated the total environmental complex (see Larsen 1965). The high heat-exchange capacity of water results in deeper active layers along shorelines and this may account for persistence of spruce northward along waterways and rivulets in regions where upland and inland areas are devoid of even dwarfed trees, excepting perhaps the rare relicts which can be seen to persist at times on what appear to be most unlikely upland sites. A number of other factors also known to affect growth of trees at the forest border are presented by Savile (1963).

It remains to be considered whether the floristically depauperate communities of the ecotone region at, and near, the forest border may not be, at least partially, the consequence of movement of the forest border within recent geologic time. The evidence indicates (Nichols 1967) that the forest retreated from a former position, at or near Dubawnt Lake, somewhat more than 3500 years ago. It appears to have fluctuated north and south of its present position at the south end of Ennadai Lake since that time, having produced two fossil soil profiles, one overlying the other, which have been observed at the south end of the lake (Bryson et al. 1965). These periods of soil formation were separated by a period in which aeolian sand blew over the profiles from nearby eskers, indicating an interval during which the area was drier, and probably colder, than it is at the present time. Forest occupied the Dimma Lake area, about 50 miles north of Ennadai Lake, as well as the north end of Ennadai Lake, some 900 years ago. Evidence from pollen deposited

in a peat bank at the edge of Ennadai Lake indicates that *Picea* has not moved north of Ennadai Lake within the past 630 years (Nichols 1967). Since many arctic species probably are incapable of persisting beneath a spruce canopy, even though (improbably) climatic conditions might otherwise be favorable, it is likely that these species would be absent from an area recently occupied by spruce forest until sufficient time had elapsed for migration and recolonization. The evidence (Savile 1956, 1964, and personal communication) indicates, however, that arctic species are capable of very rapid migration into environmentally suitable areas, since many opportunities exist for dispersal by animals and by physical events in arctic and subarctic regions.

In the light of this evidence, it appears that the absence of species of more arctic affinities at Ennadai, for example, cannot be attributed to insufficient time for migration. It is of interest in this regard, also, that *Diapensia lapponica,* an arctic species, was found atop an unusually high hill (400–500 feet above lake level) in the Ennadai area. Thus, at least one arctic species occupies a rare site which, microclimatically, must resemble arctic areas farther north. Significantly, it has failed to become a generally frequent component of the rock field communities at Ennadai, an ecological role which it plays in the vegetation farther northward. One must assume that this, presumably, is because *Diapensia* is ill-adapted to the even very slightly more subarctic environment to be found on lower hills in the Ennadai area.

Finally, there exist one series of climatological observations that may bear importantly on the nature of the frontal zone in the region under consideration. Ragotzkie (1962) and McFadden (1965) report on observations of dates of freeze-up and break-up of lakes in central Canada, providing maps showing (for various periods in spring and fall) the position of the zone in which some lakes are frozen and some are not (i.e., the zone between the line north of which all lakes are frozen and the line south of which all lakes are open). It is of interest that this zone is notably wider in the Keewatin area, in which the above vegetational data were obtained, than in areas farther west.

The floristically depauperate zone is correspondingly wider in the Keewatin area than it is in the area, for example, around the eastern arm of Great Slave Lake and Artillery Lake. In the Keewatin area, jack pine is absent from the forest for a considerable distance (perhaps 100 miles) south of the forest–tundra ecotone at Ennadai Lake while it is found in some abundance at one point along the portage between the east arm of Great Slave Lake and Artillery Lake. Additionally, *Rhododendron lapponicum* and *Dryas* species are found at Fort Reliance within the spruce forest, but to the east along the Kazan River they are not found until one travels many miles north of the forest-tundra ecotone. The same is true of other species of arctic affinities. It is thus apparent that in the west, where the frontal zone characteristically occupies a narrower belt than in the east, boreal and arctic species overlap ranges while in the east, where the frontal zone is wide, there exists a wide gap between species typically arctic or boreal in affinities. Here there exists a wide belt in which only the more ubiquitous species are found in sufficient abundance to appear regularly with high frequencies in transects. It will be of interest and perhaps of some considerable ecological significance to explore these relationships further and attempt to determine the physiological characteristics that account for the distinctive response to the climatic conditions that prevail on the part of the species involved.

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National Museum of Natural Sciences identified voucher *Salix* specimens, and A. E. Porsild of the latter institution identified certain specimens of *Carex*.

Literature Cited

Argus, George W. 1966. Botanical investigations in northeastern Saskatchewan: The subarctic Patterson–Hasbala Lakes region. Canadian Field-Naturalist 80(3): 119–143.

Bostock, H. S. 1964. A provisional physiographic map of Canada. Paper 64-35, Geological Survey of Canada, Ottawa.

Bryson, Reid A. 1966. Airmasses, streamlines, and the boreal forest. Geographical Bulletin (Canada), 8(3): 228–269.

Bryson, Reid A., William N. Irving and **James A. Larsen.** 1965. Radiocarbon and soil evidence of former forest in the southern Canadian tundra. Science (Washington) 147(4653): 46–48.

Hare, F. Kenneth and **J. C. Ritchie.** 1972. The boreal bioclimates. Geographical Review 62: 333–365.

Hustich, Ilmari. 1966. On the forest–tundra and the northern tree-lines. Annals of the University of Hurku, A, II: 36 (Reports of the Kevo Subarctic Station 3), 7–47.

Larsen, J. A. 1965. The vegetation of the Ennadai Lake area, N.W.T.: Studies in Arctic and Subarctic bioclimatology. Ecological Monographs 35(1): 37–59.

Larsen, J. A. 1971a. Vegetation of the Fort Reliance and Artillery Lake areas, N.W.T. Canadian Field-Naturalist 85(2): 147–167.

Larsen, J. A. 1971b. Vegetation and airmasses: Boreal forest and tundra. Arctic 24(3): 177–194.

Larsen, J. A. 1972a. The vegetation of northern Keewatin. Canadian Field-Naturalist 86(1): 45–72.

Larsen, J. A. 1972b. Growth of spruce at Dubawnt Lake, Northwest Territories. Arctic 25(1): 59.

Larsen, J. A. 1972c. Observations of well-developed podzols on tundra and of patterned ground within forested boreal regions. Arctic 25(2): 153–154.

Lee, H. A. 1959. Surficial geology of southern district of Keewatin and the Keewatin Ice Divide, Northwest Territories. Geological Survey of Canada Bulletin 51: 1–42.

McFadden, James D. 1965. The interrelationships of lake ice and climate in central Canada. Technical Report No. 20, Nonr 1202(07), Department of Meteorology, University of Wisconsin, Madison, Wisconsin.

Nichols, Harvey. 1967. Pollen diagrams from subarctic central Canada. Science (Washington) 155 (3770): 1665–1668.

Ragotzkie, Robert A. 1962. Operation freeze-up: An aerial reconnaissance of climate and lake ice in central Canada. Technical Report No. 10, Nonr 1202(7), Department of Meteorology, University of Wisconsin, Madison, Wisconsin.

Ritchie, J. C. 1959. The vegetation of northern Manitoba. I. Studies in the Subarctic. Technical Paper No. 3, Arctic Institute of North America, Montreal.

Savile, D. B. O. 1956. Known dispersal rates and migratory potentials as clues to the origin of the North American biota. American Midland Naturalist 56: 434–453.

Savile, D. B. O. 1963. Factors limiting the advance of spruce at Great Whale River, Quebec. Canadian Field-Naturalist 77(2): 95–97.

Savile, D. B. O. 1964. North Atlantic biota and their history (a review). Arctic 17(2): 137–141.

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The Biological Status of Pitch Pine, *Pinus rigida* Miller, in Ontario and Adjacent New York

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Abstract. The number of pitch pine in 18 isolated populations is decreasing at the present time. Several characteristics of the stands and sites are described but no relationships between edaphic features and stand size or stand presence/absence could at this time be inferred. A migration route by which the pine came into Ontario is proposed.

Introduction

Pinus rigida is one of Canada's rarest trees. Only two localities are known: one population occurs near Cairnside, Chateauguay County, Quebec; the other location comprises several populations in the Thousand Island Region, Leeds County, Ontario. *Pinus rigida* had been reported (Macoun 1886, p. 467) in the valley of the St. John River, New Brunswick, but the presence of this stand has never been verified nor are any herbarium specimens extant.

Originally the purpose of this study was to survey the Thousand Island Region and to document the distribution of these isolated populations using aerial infrared photography and aerial sightings. This aspect was completed by R. E. Beschel and D. Adlam in 1965 and 1966 (Adlam 1967). Subsequently I verified dubious sightings on foot and took a census of the isolated pitch pine populations. The results of this census, which was carried out from 1966 to 1972, indicate that the number of pine stems is decreasing. The Sand Lake stand near Jones Falls, Ontario (013/334, 31 c/9 East) had 137 stems in 1967; a census taken in 1972 showed a decrease of 22 trees. The Rock Dunder stand near Morton, Ontario (031/309, 31 c/9 East) had nine trees in 1968 and three trees in 1972. The Mount Fitzsimmons stand near Ivy Lea, Ontario (172/134, 31 c/8 East) had 97 trees in 1967, but winter kill, porcupine damage, and windthrow had reduced this population by 11 stems in 1972. The Landon Bay stand (159/119, 31 c/8 East) was burned in 1967. Careful searches in 1970 and 1971 revealed no establishment of pitch pine seedlings; no regeneration from basal crooks was observed, nor had there been any vegetative regeneration from bole sprouts. The Blue Mountain stand (218/290, 31 c/12 West) had 37 trees chopped down for bonfires in 1970.

It now seems more important, therefore, to document salient characteristics of these isolated populations, in order to establish a bench mark for future observations. Initially it had been thought that microclimatic differences could account for the distribution pattern given in Figure 1. However, observations carried out during the summer of 1968 showed that diurnal fluctuations of soil temperatures, ground level temperatures, and air temperatures were as pronounced on a single outcrop as between adjacent outcrops regardless of the presence or absence of pitch pine. Observations made during the winter of 1968–1969 concerning depth and duration of snow cover showed the same pattern. Hence, the microclimatic approach was abandoned.

Subsequently several edaphic characteristics were examined, namely: bedrock type, soil depth, soil pH, loss on ignition, and continuity of soil cover. Perhaps differences in these characteristics could account for the observed distribution of pitch pine populations. However, since the pitch pine was not observed in the

Thousand Islands on calcite outcrops, on limestone pavements, on rapidly weathering outcrops, on glacial deposits, or on clay plains, these sites were excluded from the sampling universe. Thus, sampling was restricted to 11 slow-weathering outcrops on which pitch pine did occur, 9 slow-weathering outcrops from which pitch pine was absent, and for comparison 3 outcrops on which jack pine occurred. These jack pine populations (which are represented by three solid triangles in Figure 1) represent a southern outlier of what is regarded as a typical boreal forest floristic element (Scoggan 1966). Also included in the sampling regime were three sandstone pavements on which the pitch pine occurred and three sandstone pavements where this species was absent.

Method

Sampling Procedure

At each of these sampling sites, 30 points per hectare were selected at random. If such a point was exposed bedrock (with or without epipetric lichens), a fragment was chipped away and taken to Queen's University Geology Laboratory for identification; otherwise the soil depth was recorded, a core removed and taken to the laboratory for drying and analysis. To assess continuity of soil cover, a 200-m transect was laid out at each site and at meter intervals the nature of the substrate (soil or exposed bedrock) was recorded.

To determine the age of the pitch pine population on a sample site, increment cores were taken from six trees, selected at random but having different diameters at breast height. If the stand comprised 1000 trees or more, several disks were taken from severely stunted individuals so that the number of false rings in the annual ring sequence could also be assessed.

Analysis of the Soil Samples

To determine soil pH, a 40-gm volume of pulverized soil was mixed with an equal volume of 0.01 M $CaCl_2$ solution, and allowed to settle for 30 minutes before the pH reading was taken and recorded.

Another subsample of 100 gm was ignited at 500°C and burned for 6 hours in order to assess the amount of organic debris present in the sample.

Results and Discussion

The results are given in summary form in Table 1. No significant differences in edaphic characteristics were found between outcrops on which pitch pine occur and outcrops where pitch pine is absent or where jack pine is present. However, several tendencies may be noted.

(1) *Pinus rigida* occurs most frequently on quartzite outcrops. These outcrops weather very slowly and have a very acid, discontinuous, shallow, organic soil. Quartzite ridges are quite

TABLE 1. Comparison of edaphic characteristics found on pitch pine sites with sites where the pine is absent.

Pinus rigida	Bedrock	Soil pH*	Soil depth, cm*	Percentage loss on ignition*	Exposed bedrock, frequency	Samples, n
Present	Quartzite	3.17±0.33	12±6	37±11	39/100	86
Absent	Quartzite	3.02±0.23	9±4	37±8	42/100	25
Present	Granite/–gneiss	3.51±0.29	14±6	35±12	21/100	76
Absent	Granite/–gneiss	3.69±0.38	13±9	30±9	25/100	142
Present	Sandstone	3.52±0.41	12±8	27±8	13/100	24
Absent	Sandstone	4.42±0.25	20±15	18±5	4/100	19
Jack pine	granite/–gneiss	3.56±0.36	15±8	30±11	28/100	39

*Value ± one standard deviation.

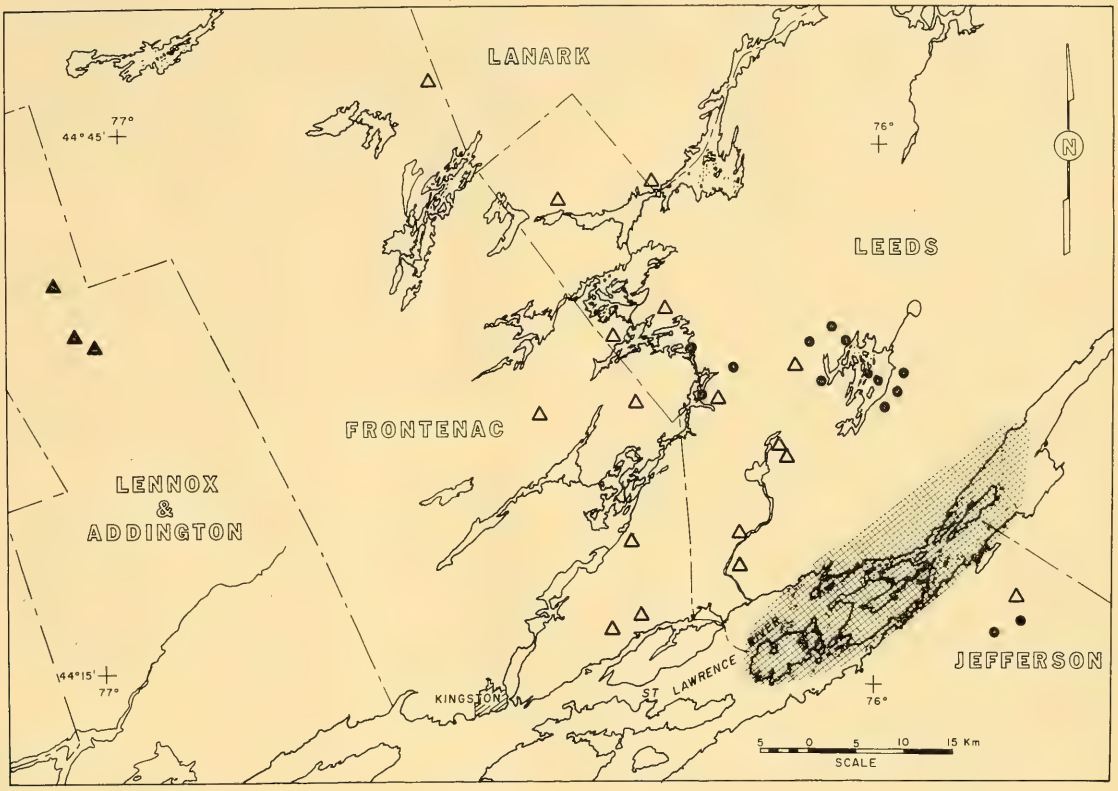

FIGURE 1. The distribution of *Pinus rigida* in Ontario and adjacent New York. Solid dots indicate isolated populations; shading is used where populations are contiguous, and open triangles indicate slow-weathering outcrops where pitch pine is absent. The solid triangles indicate isolated populations of *Pinus banksiana*.

rare in the Thousand Island region. Only 14 were found; however, 11 of these supported pitch pine.

(2) The obverse apparently holds for the granite or granite–gneiss outcrops. Out of the 80 outcrops examined, only 21 had pitch pine; 19 of these occur in the area marked as contiguous in Figure 1. Isolated populations occur most frequently on quartzite. Only two isolated populations occur on granite *viz.* Rock Dunder near Morton and Crow Island in Charleston Lake. However, the soil on these granite ridges and outcrops differs only in quantity from that on quartzite outcrops.

(3) The differences between sandstone pavements on which pitch pine occur and from which they are absent are more sharply defined. On the better developed profiles over sandstone pitch pine was not observed.

Description

The pitch pine which occurs on top of quartzite and granitic ridges often has a stunted, clumped appearance; these clumps are comprised of several twisted crown-forming stems 2–5 m tall. Several disks had been taken to determine the age of these trees: a 3-cm disk had 36 annual rings and 11 false or partial rings; a 4-cm disk had 45 annual rings and 8 false rings; a 16.5-cm disk had 97 annual rings and 17 false rings. In wet depressions on these ridges, or on talus slopes, or on partially developed soil over sandstone, the tree has a single stem and is up to 15 m high; several

trees have diameters over 42 cm at breast-height; an increment core from one of these trees gave an apparent age of 112 years. This description closely matches that of Rouleau (1955) who reported on an isolated stand of pitch pine at Cairnside, Quebec.

The needles are 3–12 cm long, twisted, sharply angled, and are borne in fascicles of three. They persist for 2 or 3 years on trees which occur on outcrops, longer on trees in sheltered and more mesic sites.

In the Thousand Islands, the staminate flowers become visible during the latter part of May; pistillate flowers about May 24th. Pollen dispersal usually occurs during the first and second weeks of June. Female cones mature in the fall of the third year. None of the cones observed in the Thousand Islands are serotinous; i.e., all cones open shortly after maturity and disperse their seed. This observation agrees with that found by Ledig and Fryer (1972).

Pinus rigida is native to the Thousand Island region of Ontario where small disjunct populations occur on shallow acid soils over granitic or quartzite outcrops, or on shallow-to-moderately-developed soils over sandstone pavements or rarely on oak-wood slopes of the outcrops. All these sites are very dry during July and August. This observation is corroborated by a substantial number of false rings in the annual ring sequence taken from the cross sections (disks) of stunted trees.

Geographical Distribution

The known distribution in Ontario and adjacent New York is presented in Figure 1. Each dot represents a disjunct population for which there is a personal field observation. Only in the Thousand Islands *per se* are several populations contiguous.

Outside the Thousand Island area, the nearest pitch pine populations are about 100 km to the South and about 190 km to the East–namely the sandy shores of Lake Oneida near Syracuse, New York and the rocky outcrops surrounding Lake Champlain, New York. The absence of *P. rigida* between these points may be attributed to the lack of suitable habitats. The intervening landscape is mostly glacial deposits over limestone or clay plains or limestone pavements. The occurrence of pitch pine on these substrates has not been reported. All published reports stipulate or infer an acid substrate (Illick and Aughanbaugh 1930; Rouleau 1955; Little 1959).

Communities

In Ontario *Pinus rigida* occurs in the open, but pure stands are found only on quartzite outcrops. On granite and granite–gneiss outcrops it may be co-dominant with one or two of the following species: *Pinus strobus, Juniperus virginiana, Quercus borealis, Q. alba, Acer rubrum.* Often the pine is only a minor component in these parklands.

Shrubs frequently associated with pitch pine include *Vaccinium angustifolium, Gaylussacia baccata, Aronia melanocarpa, Amelanchier sanguinea, A. spicata, Prunus virginiana,* and *Juniperus communis.* On a few pitch pine outcrops *Vaccinium pallidum, V. stamineum,* and *Rhus copallina* are common.

History

Assuming the necessity of an acid substrate for successful migration and colonization, by what route could the pitch pine have migrated into Ontario from its Appalachian refugia after the Cochrane Advance (± 8000 years ago) had subsided? The only continuous "acid route" is northwards, up the Hudson Valley, thence westwards along the Mohawk River up to and around the shores of Lake Oneida to the Oneida River and subsequently northwards again along the Black River, into the Butterfield Lake area, the Thousand Islands, and points further west and north. Scattered along this route are several isolated populations *viz.* on the shores of Lake Oneida, in the vicinity of Utica and on the sand plains near Schenectady and Albany. Along the Hudson trench the pitch pine populations are contiguous. Although other migratory routes may exist, this one is at least probable.

Literature Cited

Adlam, W. D. 1967. Pitch pine in Ontario. The 1000 Islander, Gananoque, Ontario, August 26, 1967. p. 9.

Illick, J. S. and **J. E. Aughanbaugh.** 1930. Pitch pine in Pennsylvania. Pennsylvania Department of Forests and Waters Research Bulletin 2. 108 pp.

Ledig, F. T. and **J. H. Fryer.** 1972. A pocket of variability in *Pinus rigida*. Evolution 26: 259–266.

Little, S. 1959. Silvical characteristics of pitch pine. Northeastern Forest Experimental Station, Upper Darby, Pennsylvania, Station Paper Number 119.

Macoun, J. 1886. Catalogue of Canadian plants. Part III, Apetalae. Dawson Brothers, Montreal.

Rouleau, E. 1955. *Pinus rigida* Miller in Quebec. Rhodora 57: 299.

Scoggan, H. J. 1966. The Flora of Canada. Reprinted from Canada Year Book 1965–1966, Queen's Printer, Ottawa, Ontario.

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Rock-inhabiting Lichens of the Frontenac Axis, Ontario[1]

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Wong, P. Y. and I. M. Brodo. 1973. Rock-inhabiting lichens of the Frontenac Axis, Ontario. Canadian Field-Naturalist 255-259.

Abstract. One hundred and one saxicolous lichen taxa in 39 genera and 22 families are reported from a hard rock area of the Frontenac Axis of eastern Ontario. Substrate and habitat type of all species are recorded. Twenty-nine species and one form are reported as new for Ontario.

Introduction

Collections of lichens have been made in eastern Ontario for over a century. Billings (1862) listed 85 species of lichens collected within 4 miles of Prescott. A. T. Drummond collected many lichens in the Kingston region during 1863 and 1864. He never published special lists of these collections, but they were undoubtedly included in his contribution to Watt's (1865) catalogue. Most of these specimens are deposited in the Fowler Herbarium of Queen's University (QK). Seventy-five species and varieties of lichens from within 30 miles of Ottawa were reported by Macoun (1898, 1906). Earlier collections made by him from Belleville in 1865 and 1868 are also deposited at QK. These early published records are, of course, very much out of date.

More recently, lists of 153 lichens of the Ottawa area were published by Brodo (1967a, 1967b, 1972); Webber (1963) recorded seven corticolous lichens in a study of swamp forests in eastern Ontario; Lambert and Maycock (1968) published the results of studies of "terricolous" lichens in central and eastern Canada (actually covering epiphytic, epipetric, and epigaeic species). The purpose of the present paper is to record the saxicolous lichens in the hard rock area of the Frontenac Axis of eastern Ontario, together with some ecological information about each species. The field work was carried out in the summers of 1967 and 1968.

[1]This paper is part of a M.Sc. Thesis submitted by the first author to the Department of Biology, Queen's University, Kingston.

Description of the Area

The hard rock area of the Frontenac Axis has been described by Beschel et al. (1962), so only brief comments will be made here. The area studied is a quadrat of 50×50 km^2 with its sides following UTM grid lines (Figure 1). The predominant bedrock is Precambrian in age, mainly composed of gneiss, granite, quartzite, and crystalline limestone. Ordovician limestone is not represented except by erratic boulders.

The climate of the area has been described in a wider framework for all of southern Ontario by Putnam and Chapman (1938) and a shorter summary was given by Jafri (1965). The only permanent weather station within the area is at Kingston.

The area lies in the Dbf climate region of Köppen's classification (as modified by Trewartha 1966) but in exceptional years a Daf condition is reached, with the warmest month exceeding the mean temperature by 22° Centigrade. The average yearly precipitation of 833 mm is rather equally distributed over the year with monthly means between 55 mm in February and 76 mm in October. However, precipitation fluctuates greatly in individual years and severe drought conditions may occur in mid summer.

A yearly average of 1500 mm of snow falls in the area, mostly during several storms, but

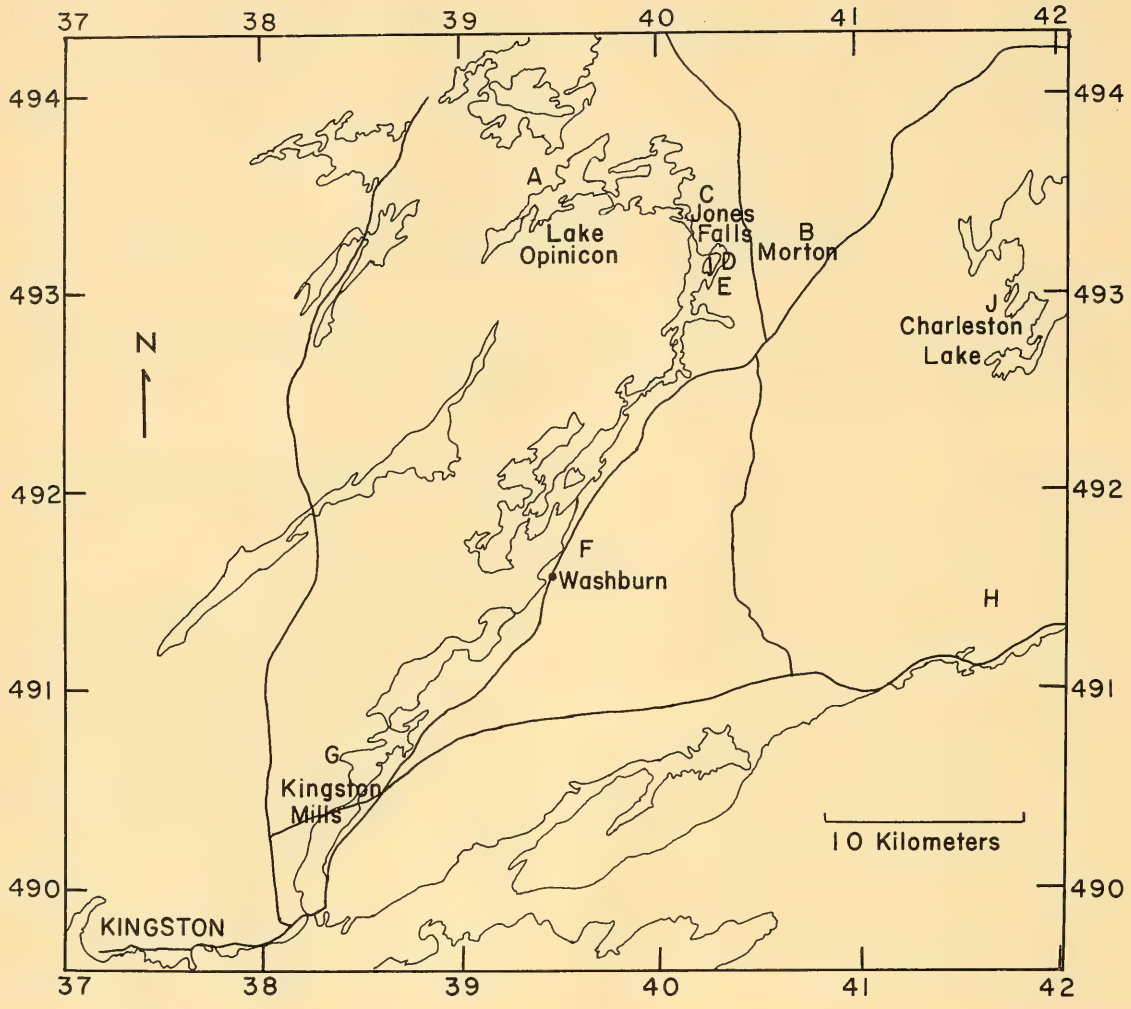

FIGURE 1. Localities at which specimens reported in this paper were collected. A. Lake Opinicon. B. Pitch pine ridge near Morton. C. Jones Falls. D. Rock Dunder. E. Dunders Mate and Whitefish Lake. F. Washburn Cliff. G. Kingston Mills. H. Mt. Fitzsimmons. I. Dean Island. J. Charleston Lake.

the snow may melt completely in any winter month.

Locally, the climate seems to be extremely variable, being influenced by the rugged landscape of dry rocky ridges and swampy valleys with numerous frost pockets.

Close to Lake Ontario the climate is slightly more "oceanic" because of the moderating influence of the lake, the climate becoming more continental northeastward. This is shown by an increase of the temperature amplitude of the monthly means from 28.7 to 29.6° Centigrade over a distance of 50 km. The amplitude of the extremes increases over the same distance from 71.1 to 79.4° Centigrade. These values were interpolated from the maps of Putnam and Chapman (1938).

The area is included within the eastern section of the Great Lakes – St. Lawrence forest region of Rowe (1959), the beech–maple forest of Knapp (1965), and the hemlock–white pine northern hardwoods region of Braun (1950).

A varied landscape and a wide range of environments make for great vegetational diversity. Beschel (1965) states, "Nowhere in Canada outside of the mountains does the overall pattern of vegetation and flora change so intensively over such short distances. Between the shore of Lake Ontario and some 20 miles within the Precambrian shield, over a distance of about 40 miles, more than 70 flowering plants reach their northern or northwestern limit of distribution."

The Frontenac Axis has an intense relief of ridges and depressions which are generally oriented west–southwest to east–northeast. The ridges rarely rise more than 40 m above the valleys. Pleistocene ice sheets scraped the area and left little drift. The development of vegetation on many outcrops has been retarded by the lack of fine material, and a lichen cover similar to today's may well have existed on many of these outcrops for the last 10,000 years. Cutting and burning of the vegetation by settlers in the last 300 years may have exposed some rocks which had been covered by forest, but many lichens in this region are probably older than 300 years old (Beschel 1965). Lichenometry could be used to determine which rocks had already been colonized before white settlement but no such studies have been done.

Annotated List of Species

A collection of 400 saxicolous specimens was made, including 97 species, three varieties, and one form in 39 genera and 22 families. Only the new records for Ontario (29 species and one form) and those of particular interest because of their rarity or poorly known distribution (seven species, each preceded by an asterisk) are listed below with ecological notations. The other species are listed separately. Some of the species reported here as new Ontario records have previously been recorded as from the "Ottawa region" (Brodo 1972), but the latter records were based on specimens collected in Quebec. The complete annotated list of species is available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

A complete set of voucher specimens is in the Fowler Herbarium of Queen's University (QK), and many duplicates are in the National Herbarium of Canada (CANL). The arrangement of families, and the genera within families follows Hale and Culberson (1970). Species have been placed in alphabetical order within the genera. The senior author's voucher number follows each name. Although in most cases more than one specimen was collected of each species, only a single specimen is cited.

Habitat types and substrates of each species are listed (separated by a semicolon). They are symbolized as follows.

Habitat types:

ER, Exposed Ridges, with an inclined surface
RT, Ridge Tops, on top of open ridges, mostly of acidic rocks such as quartz and granite
BT, Boulder Tops, on top of open boulders
OS, Open Slopes
SL, Shores of Lake, frequently wave-washed
OF, Open Forest slopes
MF, moderately shaded, moderately Moist Forest slopes
LF, Relatively well Lighted cliffs in Forest
DC, Dry, shaded Cliffs
SC, strongly Shaded, dry Cliffs
MC, Moist Cliffs in forest
SF, Shaded boulders in Forest
WF, Wet shaded slopes in Forest
WC, Wet Cliffs in forest

Substrates

G, hard rock (granite or gneiss)
Q, quartzite
L, limestone or calcareous sandstone
S, noncalcareous sandstone
M, over mosses on rock

If one substrate clearly predominates for a species, it is italicized.

PANNARIACEAE

**Pannaria microphylla* (Sw.) Mass. 256 WF; G

PELTIGERACEAE

Peltigera elisabethae Gyeln. 463 MF, LF; *G*,M

LECIDEACEAE

Bacidia umbrina (Ach.) Bausch 504 ST,MF; G
Lecidea brunneofusca Magn. 439 ER; G
L. cinereoatra Ach. 393 OS,BT; G
L. delincta Nyl. 328 BT,OF,WF,WC; *G*,Q
**L. erratica* Koerb. var. *planetica* (Tuck.) Lowe 327 RT; *G*,Q

L. recensa Stirt. 435 MC, DC; Q
Rhizocarpon cinereovirens (Muell. Arg.) Vain. 398 MF,LF,MC; G
R. concentricum (Dav.) Beltr. 381 DC,MC; G
R. disporum (Naeg.) Muell. Arg. 761 SL; G
**R. lecanorinum* (Koerb.) Anders 343 OS; G
R. obscuratum (Ach.) Mass. f. *reductum* (Th. Fr.) Eitn. 247 OF,LF,MC; *G*,Q,S
R. plicatile (Leight.) A.L. Sm. 498 OF,SF,BT, ER; *G*,Q,S
R. tetramerum Vain. 468 BT, OS; *G*,Q,S
Toninia caeruleonigricans (Lightf.) Th. Fr. 325 MF; L

CLADONIACEAE

Cladonia carolininana (Schwein.) Tuck. 290 BT; *G*,M

ACAROSPORACEAE

Sarcogyne clavus (Ram.) Kremp. 499 ER,RT; *G*,Q
S. Privigna (Ach.) Mass. 433 BT, OS,MC; *G*,Q
S. simplex (Dav.) Nyl. 497 BT,OS; G

LECANORACEAE

Haematomma sp. sensu Brodo (1968) 447 SC; S
Lecanora polytropa (Ehrh.) Rabenh. 305 OS, SL,BT, MF; *G*,Q
L. campestris N. Amer. auct.[2] 351 BT,SL,ER, OS,OF,MF; *G*,Q
L. verrucigera (Hue) Zahlbr. 505 ER,OS,RT, BT,SF,MF,OF,SL,LF,MC,WF; *G*,Q,S

PARMELIACEAE

Parmelia plittii Gyeln. 474 RT,BT,ER,SL,OF, MF,SF,MC,WF,LF; *G*,Q,S
**P. sorediosa* Almb. 571 ER,OS,MC,BT,OF,LF, DC; *G*,Q

RAMALINACEAE

**Ramalina pollinaria* (Westr.) Ach. 233 SC,DC, MC; *G*,Q

BUELLIACEAE

Buellia turgescens Tuck. 441 RT,BT; *G*,Q
**Rinodina ascociscana* Tuck. 424 SL,WF,MF, WC; G
R. verrucosa Merrill *ex* Sheard 478 SL; G

TELOSCHISTACEAE

Caloplaca cfr. *amabilis* Zahlbr. 452 MF,WF; G
**C. feracissima* Magn. 374 OF; G

[2]This is not conspecific with *Parmelia subfusca* ζ. *campestris* Schaer. This problem will be discussed in a revision of the North American *Lecanora subfusca* group, now in preparation by Brodo.

VERRUCARIACEAE

Endocarpon pusillum Hedw. 412 MF,SF; L
Staurothele diffractella (Nyl.) Tuck. 423 WF, MC,WC; G
Verrucaria calkinsiana Serv. 231 OF; S
V. nigrescentoidea Fink 501 WC,MF,SF; G

LICHENES IMPERFECTI

Lepraria zonata Brodo 215 OS,OF,ER,BT,MF, SF,MC,LF,DC,WC,SL,RT; *G*,Q,S

The following taxa were also found:

Collema subfurvum (Muell. Arg.) Degel.
Leptogium cyanescens (Pers.) Koerb.
L. lichenoides (L.) Zahlbr.
Placynthium nigrum (Huds.) S. Gray var. *nigrum*
Peltigera canina (L.) Willd. var. *canina*
Nephroma parile (Ach.) Ach.
Lobaria pulmonaria (L.) Hoffm.
L. quercizans Michx.
Lecidea albocaerulescens (Wulf.) Ach.
L. macrocarpa (DC.) Steud.
Lecidella stigmatea (Ach). Hert. & Leuck.
Rhizocarpon grande (Floerke *ex* Flot.) Arn.
Stereocaulon saxatile Magn.
Cladonia chlorophaea (Floerke) Spreng. sens. str.
C. coniocraea (Floerke) Spreng.
C. furcata (Huds.) Schrad.
C. grayi Merr. *ex* Sandst.
C. macilenta Hoffm.
C. pyxidata (L.) Hoffm.
C. squamosa (Scop.) Hoffm.
C. uncialis (L.) Wigg.
Umbilicaria deusta (L.) Baumg.
U. mammulata (Ach.) Tuck.
U. muhlenbergii (Ach.) Tuck.
U. papulosa (Ach.) Nyl.
Acarospora fuscata (Schrad.) Arn.
Lecanora calcarea (L.) Somm.
L. cinerea (L.) Somm.
L. dispersa (Pers.) Somm.
L. muralis (Schreb.) Rabenh.
L. chrysoleuca (Sm.) Ach.
Candelaria concolor (Dicks.) B. Stein
Candelariella aurella (Hoffm.) Zahlbr.
C. vitellina (Ehrh.) Muell. Arg.
Cetraria oakesiana Tuck.
Cetrelia olivetorum (Nyl.) W. Culb. & C. Culb.
Hypogymnia physodes (L.) W. Wats.
Parmelia caperata (L.) Ach.
P. conspersa (Ach.) Ach.
P. cumberlandia (Gyeln.) Hale
P. rudecta Ach.
P. subaurifera Nyl.
P. sulcata Tayl.
P. taractica Kremp.
Alectoria nidulifera Norrl. *ex* Nyl.
Ramalina intermedia Del. *ex* Nyl.
Dimelaena oreina (Ach.) Norm.
Rinodina cfr. *confragosa* Tuck.
Physcia caesia (Hoffm.) Hampe
P. dubia (Hoffm.) Lett.
P. millegrana Degel.
P. orbicularis (Neck.) Poetsch
P. stellaris (L.) Nyl.

Physconia grisea (Lam.) Poelt
Caloplaca cfr. *aurantiaca* (Lightf.) Th. Fr.
C. flavovirescens (Wulf.) Dalla Torre & Sarnth.
Xanthoria elegans (Link) Th. Fr.
Diploschistes scruposus (Schreb.) Norm.
Dermatocarpon fluviatile (G. Web.) Th. Fr.
D. miniatum (L.) Mann
Verrucaria muralis Ach.
V. nigrescens Pers.
Lepraria incana (L.) Ach.
L. membranacea (Dicks.) Vain.

Acknowledgments

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Literature Cited

Beschel, R. E. 1965. Comments on the vegetation of the Kingston region. Blue Bill 12: 32–36.

Beschel, R. E., P. J. Webber, and **R. Tippet.** 1962. Woodland transects of the Frontenac Axis region, Ontario. Ecology 43: 386–396.

Billings, B., Jr. 1862. List of plants observed growing principally within four miles of Prescott, C. W., and for the most part in 1860. Annals of the Botanical Society of Canada 1: 114–140.

Braun, E. L. 1950. Deciduous forests of Eastern North America. The Blakiston Company, Philadelphia. xiv + 596 pp.

Brodo, I. M. 1967a. Lichens of the Ottawa area. I. Trail and Landscape 1: 40–45.

Brodo, I. M. 1967b. Lichens of the Ottawa area. II. The fruticose species. Trail and Landscape 1: 114–115, 118–121.

Brodo, I. M. 1968. The lichens of Long Island, New York: A vegetational and floristic analysis. Bulletin, New York State Museum 410. x + 330 pp.

Brodo, I. M. 1972. Lichens of the Ottawa area. III. The crustose species. Trail and Landscape 6: 15–26.

Hale, M. E. and **W. L. Culberson.** 1970. A fourth checklist of the lichens of the continental United States and Canada. Bryologist 73: 499–543.

Jafri, S. 1965. Forest composition in the Frontenac Axis region, Ontario. M.Sc. Thesis, Queen's University, Kingston, Ontario. ix + 172 pp.

Knapp, R. 1965. Die Vegetation von Nord- und Mittelamerika und der Hawaii-Inseln. Gustav Fisher, Stuttgart. xi + 373 pp.

Lambert, J. D. and **P. F. Maycock.** 1968. The ecology of terricolous lichens of northern conifer-hardwood forests of central eastern Canada. Canadian Journal of Botany 46: 1043–1078.

Macoun, J. 1898. The cryptogamic flora of Ottawa. Ottawa Naturalist 12: 25–32, 49–56, 93–100.

Macoun, J. 1906. The cryptogamic flora of Ottawa. Ottawa Naturalist 20: 177–186.

Putnam, D. F. and **L. J. Chapman.** 1938. The climate of southern Ontario. Scientific Agriculture 18: 401–446.

Rowe, J. S. 1959. Forest regions of Canada. Department of Northern Affairs and National Resources, Forestry Branch, Bulletin 123. 71 pp.

Trewartha, G. T. 1966. Earth's problem climates. University of Wisconsin Press, Madison, Wisconsin. vi + 334 pp.

Watt, D. A. P. 1865. A provisional catalogue of Canadian cryptogams. Canadian Naturalist and Geologist 2(N.S.): 390–404.

Webber, P. J. 1963. Vegetation gradients in swamp forests of Eastern Ontario. M.Sc. Thesis, Queen's University, Kingston, Ontario. iii + 231 pp.

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Three Plant Species New to Canada on Pelee Island: *Triosteum angustifolium* L., *Valerianella umbilicata* (Sull.) Wood, and *Valerianella intermedia* Dyal

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DUNCAN, T. 1973. Three plant species new to Canada on Pelee Island: *Triosteum angustifolium* L., *Valerianella umbilicata* (Sull.) Wood, and *Valerianella intermedia* Dyal. Canadian Field-Naturalist 87: 261-265.

Abstract. *Triosteum angustifolium, Valerianella umbilicata,* and *V. intermedia* were collected on Pelee Island, Essex County, Ontario, Canada. This is the first report of these species in Canada. Distribution maps for each species are included with comments concerning the phytogeography of these three range extensions. An unique assemblage of plants, found in association with these three species, for the Erie Islands, is listed and discussed.

During a research trip on Pelee Island, Essex County, Ontario, Canada on 28–30 May 1971, *Triosteum angustifolium* L., *Valerianella umbilicata* (Sull.) Wood, and *V. intermedia* Dyal were discovered. According to Boivin (1966a, 1966b, personal communication) and Soper (1949), these three species have never been reported for Canada.

Of the 21 islands in western Lake Erie, Pelee Island is the largest, with an area of 10,000 acres (Kindle 1937; Core 1948). Pelee and Middle Islands are the southernmost portions of Ontario and of Canada.

These three species were discovered west of Stone Road three-tenths of a mile south of East and West Road (Figure 1). Six plants of *T. angustifolium* were found in one small clump approximately 100 yards west of Stone Road. One specimen was taken (Duncan 1509, OS). The plants were growing in a dry open woods dominated by *Quercus bicolor* and *Fraxinus americana.* Other common associated woody species were *Celtis occidentalis, Carya ovata, Ptelea trifoliata,* and *Tilia americana.* Approximately 25 plants of *Valerianella umbilicata* and *V. intermedia* were found in an open thicket dominated by *Rhus aromatica, Cornus drummondii,* and *Crataegus mollis* farther to the west of Stone Road. A single voucher of *Valerianella intermedia* was collected (Duncan

FIGURE 1. Map of Pelee Island (from Kindle 1937). Square located in the southwestern corner of the island indicates site of collection of *Triosteum angustifolium, Valerianella umbilicata,* and *V. intermedia.*

1504, OS). During a return trip on 17–18 June 1972, no trace of *Triosteum angustifolium* could be found. *Valerianella umbilicata* and *V. intermedia,* however, were more abundant than in 1971 with approximately 100 plants scattered throughout the thicket. Two vouchers each of *V. umbilicata* (Duncan 2015A, DAO, OS) and *V. intermedia* (Duncan 2015, DAO, WMU) were collected.

Triosteum angustifolium is the most southern species of its genus, which is widespread in the eastern United States (Lane 1954). *T. angustifolium* occurs from Connecticut to eastern Kansas and eastern Texas, and south to Alabama and North Carolina (Figure 2). Its distribution is almost exclusively south of the boundary of the maximum extent of the Wisconsin glaciation.

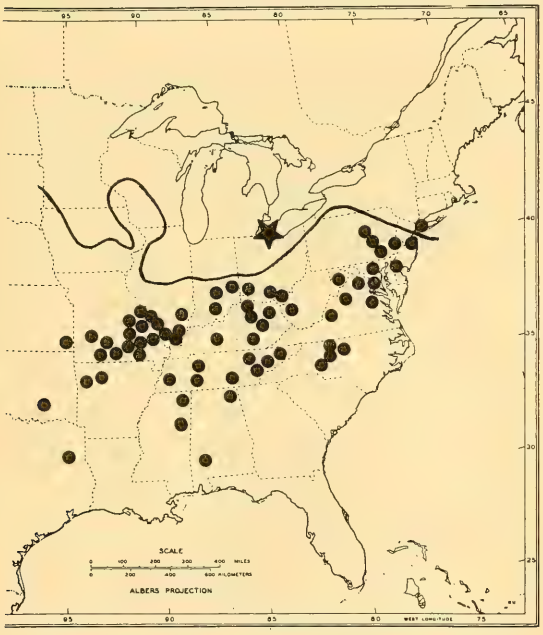

FIGURE 2. Distribution of *Triosteum angustifolium* in North America (after Lane 1954). Line indicates the maximum extent of the Wisconsin glaciation. The star indicates location of collection from Pelee Island. Solid circles indicate the location of one or more collections. Goode Base Map, copyright by the University of Chicago, permission by Department of Geography.

The magnitude of the range extension for this species is not known. The distribution in Figure 2 would indicate a 150-mile disjunction north of the nearest known location in southern Ohio. Hauser (1965) mapped *T. angustifolium* from several locations north of the Wisconsin glacial boundary in Ohio. The Pelee Island location, according to this treatment, would then be approximately 50 miles north of the nearest known location. Problems exist, however, in Hauser's treatment of *Triosteum* in Ohio. The specimens he examined from several of these northern localities have character states not found in *T. angustifolium.* Hauser specifically mentioned that many of the specimens from these northern locations have more than one flower per leaf axil and that the stipules do not extend beyond the sepals. According to Lane (1954), these character states are diagnostic for *T. aurantiacum.* All the specimens at The Ohio State University Herbarium from the northern localities are *T. aurantiacum.* Until all other specimens have been checked, and the correct distribution of *T. angustifolium* in Ohio has been mapped, no final statement can be made concerning the distance involved in this disjunction. It is likely, however, that in Ohio *T. angustifolium* does not occur north of the Wisconsin glacial boundary.

Cain (1944) states that minor discontinuities of area probably result frequently from recent migrations. This appears to be true in the case of *T. angustifolium.* The moderating influence of Lake Erie on the climate of the islands in the western basin and also on the north shore of the lake, where many species reach their northern limit, could be a major factor causing this disjunction. The longer growing season and greater number of frost-free days give the islands in Lake Erie a more southern climate in comparison to areas in northern Ohio not bordering the lake (Verber 1955).

Triosteum angustifolium has probably invaded Pelee Island since settlement by European man. Before man's arrival, Pelee Island was primarily a marsh with swamp forests occupying the higher ground (Hooper 1967). Early settlers, realizing the high productivity of the soil, drained the marshes and farmed the

island. An old plat map dated 1 November 1866, in the Essex County Registry Office in Windsor, Ontario, originally designated the area just to the west of where these species were discovered as swamp forest. The Stone Road location is at the edge of this former swamp forest. The drier conditions which exist now have come about during the last 100 years. Thus the vegetational history of the island, the draining of the marshes, and the use of the land for farming are conditions that have developed providing a habitat for *T. angustifolium*. The failure the following year to rediscover the population indicates that *T. angustifolium* was probably only an adventive invader of the island, and that it has probably migrated to Pelee Island very recently. It may, however, reinvade Ontario in similar dry, open, secondary successional woods.

Valerianella intermedia is more widespread in eastern North America than *T. angustifolium*.

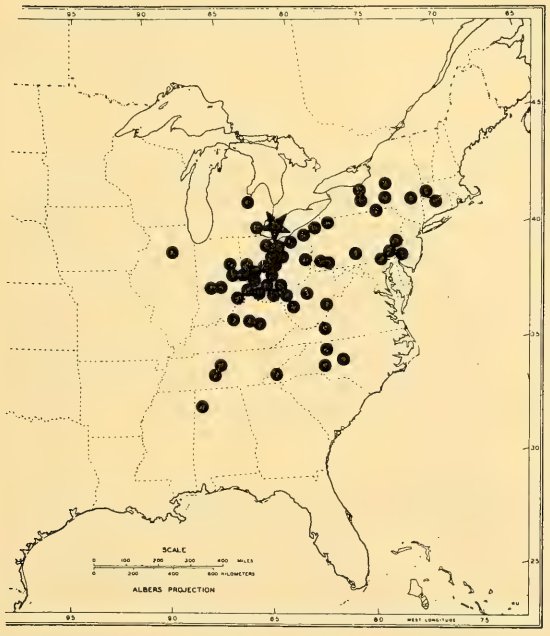

FIGURE 3. Distribution of *Valerianella intermedia* in North America (after Ware 1969). The star indicates location of collection from Pelee Island. Solid circles indicate the location of one or more collections. Goode Base Map, copyright by the University of Chicago, permission by Department of Geography.

The distribution of *V. intermedia* is mainly in Ohio, Pennsylvania, and New York, with scattered locations east into Massachusetts and south into North Carolina and Alabama, and west to Illinois (Figure 3). *V. intermedia* occurs in northern Ohio along the south shore of Lake Erie and into southwestern Michigan. Thus it is not surprising to find it now in the most southern area of Canada.

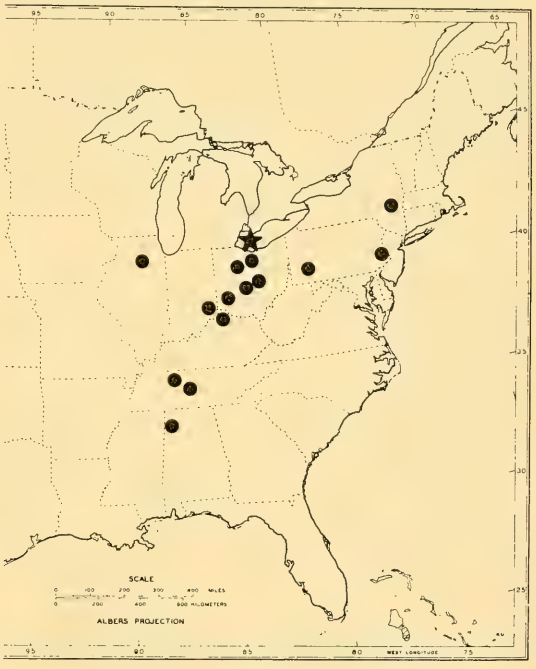

FIGURE 4. Distribution of *Valerianella umbilicata* in North America (after Ware 1969). The star indicates location of collection from Pelee Island. Solid circles indicate the location of one or more collections. Goode Base Map, copyright by the University of Chicago, permission by Department of Geography.

Valerianella umbilicata has a scattered distribution in the central section of the eastern United States (Figure 4). Much like the distribution of *V. intermedia, V. umbilicata* occurs mainly in Ohio. Isolated stations for *V. umbilicata* are known from New York to Illinois, and south to Alabama. At several localities both of these taxa have been found together (Ware 1969). The taxonomy of the genus *Valerianella* has been revised and D. M. E. Ware in her

forthcoming treatment will treat these two taxa as conspecific, but as separate intraspecific entities. However, for the purposes of this paper earlier treatments have been used. Both *V. umbilicata* and *V. intermedia* appear to be well established on Pelee Island.

According to the reasoning discussed earlier, *V. intermedia* and *V. umbilicata* appear to be recent invaders of Pelee Island. However, *V. intermedia* and *V. umbilicata* have been more successful at becoming established than *T. angustifolium*. Throughout their ranges, *V. intermedia* and *V. umbilicata* are invaders of open exposed habitats such as roadsides, fields, and thickets, often occurring in large populations. *T. angustifolium* is found in a more stable woodland habitat type with fewer individuals per population than *V. intermedia* or *V. umbilicata*. These ecological factors could account for the more successful invasion of Pelee Island by *V. intermedia* and *V. umbilicata*. *V. intermedia* and *V. umbilicata* are expected to be found elsewhere in southern Ontario.

Further investigation of the area along Stone Road has revealed an assemblage of plants unique for the Erie Islands associated with *T. angustifolium*, *V. intermedia*, and *V. umbilicata* (Table 1). Species such as *Galium boreale*, *Arenaria lateriflora*, and *Polygala senega* have primarily northern distributions. Of all the species found on Pelee Island, those which have primarily a southern distribution and which reach their northern limit in the Carolinian Zone of Canada are the most thoroughly studied (Soper 1956, 1962; Fox and Soper 1952, 1954, 1955; Macoun and Malte 1917; Stuckey 1968). Of the species listed in Table 1, *Zanthoxylum americanum* and *Ptelea trifoliata* have this type of distribution. Other species with this distribution which are occasional to common on the Erie Islands and which are also found along Stone Road are, for example, *Dioscorea villosa*, *Hydrophyllum appendiculatum*, *Carya ovata*, and *Quercus muehlenbergii*. Many other species found on Pelee Island such as *Hibiscus palustris*, *Euonymus obovatus*, *Gymnocladus dioica*, *Cephalanthus occidentalis*, and *Cyperus engelmannii* also have this type of distribution. In many respects, then, the flora of Pelee Island is of a distinctly southern nature. The discovery of *Triosteum angustifolium*, *Valerianella intermedia*, and *V. umbilicata* adds three more species to the known southern element in the flora of the Carolinian Zone of Canada.

TABLE 1. Species which are rare or unknown elsewhere on the Erie Islands, but found in association with *Triosteum angustifolium*, *Valerianella umbilicata*, and *V. intermedia* along Stone Road, Pelee Island.*

Arenaria lateriflora
Carex muskingumensis
Circaea quadrisulcata
Comandra umbellata
Cynoglossum officinale
Galium boreale
Lobelia inflata
Polygala senega
Ptelea trifoliata
Pycnanthemum virginianum
Pyrus coronaria
Ratibida pinnata
Specularia perfoliata
Symphoricarpus albus
Thaspium barbinode
Viburnum lentago
Viburnum rafinesquianum
Zanthoxylum americanum

*Nomenclature according to Fernald (1950).

Acknowledgments

Thanks are extended to the following people: Dr. James S. Pringle and Mr. James Ludwig for their assistance in field work; Dr. Bernard Boivin for comments on the occurrence of these species in Canada; Dr. D. M. E. Ware for examining the *Valerianella* specimens and for making parts of her revision available; and Dr. R. L. Stuckey and Dr. W. H. Wagner, Jr. for comments on the manuscript.

Literature Cited

Boivin, Bernard. 1966a. Enumération des plantes du Canada. II. Lignidées. Naturaliste Canadien 93: 371–437.

Boivin, Bernard. 1966b. Enumération des plantes du Canada. IV. Herbidées, 2ième partie: Connatae. Naturaliste Canadien 93: 989–1063.

Cain, Stanley A. 1944. Foundations of plant geography. Harper and Row, New York. xiv + 556 pp. Facsimile Reprint 1971, Hafner Publishing Company, New York.

Core, Earl L. 1948. The flora of the Erie Islands: an annotated list of vascular plants. The Ohio State University, The Franz Theodore Stone Laboratory Contribution Number 9. viii + 106 pp.

Fernald, M. L. 1950. Gray's manual of botany. 8th edition. American Book Company, New York. 1xiv + 1632 pp.

Fox, W. Sherwood and **James H. Soper.** 1952. The distribution of some trees and shrubs of the Carolinian Zone of southern Ontario. Part I. Transactions of the Royal Canadian Institute 29: 65–84; 1954. Part II. *opere citato* 30: 3–32; 1955. Part III. *opere citato* 31: 99–130.

Hauser, Edward J. P. 1965. The Caprifoliaceae of Ohio. Ohio Journal of Science 65: 118–129.

Hooper, Marion McCormick. 1967. Pelee Island: then and now. Published by the author. 110 pp.

Kindle, K. M. 1937. Geology of Pelee and adjacent islands. Annual Report of the Ontario Department of Mines 45(7): 75–116.

Lane, Franklin C. 1954. The genus *Triosteum* (Caprifoliaceae). Ph.D. Dissertation, University of Illinois, Urbana, Illinois. 158 pp.

Macoun J. M. and **M. O. Malte.** 1917. The flora of Canada. Canada Department of Mines Museum Bulletin Number 26. 14 pp.

Soper, James H. 1949. The vascular plants of southern Ontario. Published jointly by the Department of Botany, University of Toronto, and Federation of Ontario Naturalists, Toronto, Ontario, Canada. vi + 95 pp.

Soper, James H. 1956. Some families of restricted range in the Carolinian flora of Canada. Transactions of the Royal Canadian Institute 31: 69–90.

Soper, James H. 1962. Some genera of restricted range in the Carolinian flora of Canada. Transactions of the Royal Canadian Institute 34: 2–56.

Stuckey, R. L. 1968. Aquatic flowering plants new to the Erie Islands. Ohio Journal of Science 68: 180–187.

Verber, James L. 1955. The climate of South Bass Island, western Lake Erie. Ecology 31: 388–400.

Ware, Donna Marie Eggers. 1969. A revision of *Valerianella* in North America. Ph.D. Dissertation, Vanderbilt University, Nashville, Tennessee. 262 pp.

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The Planktonic Rotifera of Ontario with Records of Distribution and Notes on Some Morphological Variation

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Résumé. Deux cent cinquante-deux collections de plancton provenant de plusieurs régions d'Ontario étaient étudiées. Cinquante-trois espèces et deux variétés de rotifères sont rapportées, y compris huit formes décrites pour la première fois au Canada. Le nombre d'espèces dans une seule collection était comparé au nombre totale des espèces présentes par le moyen des collections régulières dans quatre lacs. La composition des rotifères planctoniques d'Ontario est typiquement artique–tempérée. Seulement deux formes sont endémiques. La variation morphologique, les dimensions, le type de fondation et l'hispidité de *Keratella* et l'introgression dans *Polyarthra* sont discutés. L'importance de quelques charactères systématiques pour l'identification des espèces, par example des noyaux dans le vitellarium, la poche de gorge dans *Polyarthra* et l'insertion de soies postérieures dans *Filinia* est sussi discutée.

Abstract. Two hundred fifty-two plankton samples collected from various parts of Ontario were studied and 53 species and two varieties of rotifers are reported, including eight new records for Canada. The number of species in a single sample, as compared to the total number of species present, was studied by regular sampling of four lakes. The composition of the Ontario planktonic rotifers shows a typical arctic–temperate species mix with only two endemics. Morphological variation, size of some species, foundation pattern, and hispidity of *Keratella* and introgression in *Polyarthra* are discussed. The importance of some taxonomic characters used in species diagnosis such as nuclei in the vitellarium, the throat pouch in *Polyarthra,* and the insertion of posterior setae in *Filinia* are also discussed.

Introduction

Studies on the systematics of Rotifera of Canada are few and scattered. There is no comprehensive study of this group based on Canadian material. The present work based on planktonic material collected in Ontario is an attempt to fill part of this gap.

The first paper dealing with rotifers from Ontario was confined to the bdelloids (Murray 1911). Odell and Harris (1933) gave a list of species collected from ponds, lakes, and rivers in the Ottawa district. Ahlstrom (1940, 1943) referred to Ontario material in his monographs on the genera *Keratella* and *Brachionus,* and *George* and Fernando (1969a) discussed the synonmy of *Keratella canadensis.* Chengalath (1971) made a detailed study of planktonic Rotifera of Ontario.

Rotifers have been recorded in some of the studies on zooplankton in Ontario. A few of the more extensive studies are those of Bigelow (1923), Mackay (1951), Anderson and Clayton (1959), Davis (1969), and George and Fernando (1969b). A key to the planktonic rotifers of Ontario has been given by Chengalath *et al.* (1972).

Many rotifers are very widely distributed and hence they can often be identified using works from other parts of the world. However, morphological variations occur throughout the geographical range of many species and regional material therefore needs careful study. In the present study, material collected over a wide area of Ontario was used. In all, 252 samples were examined, and 53 species and two varieties belonging to 22 genera were recorded. This number of species is about what is to be expected from the distribution of Rotifera in North America.

Regular sampling at short intervals of four habitats was carried out to find the order of variation in the number of species on different sampling days.

Hitherto undescribed morphological variations are recorded and described. A list of Ontario planktonic Rotifera has been made and the composition of the fauna is discussed in relation to the known latitudinal variation in rotifer faunas.

Materials and Methods

During the period 1967–1970 plankton samples were collected with a #25 mesh net having a diameter of 26 cm from the limnetic zone of many Ontario lakes. Usually a single vertical haul was taken from the bottom to the surface, or if a lake was very deep, from 20 meters to the surface. Some lakes were, however, sampled two or three times during the period of study. Four lakes were more intensively sampled. Figure 1 shows the wide portion of the province covered by the sampling.

Rotifers were fixed and preserved in 5% formalin. The identification of the illoricate Ploima is made easier by narcotization before preservation. This was done using the method of Myers (1942) when possible. The trophi were separated and studied according to the method of Myers (1937), using sodium hypochlorite.

Drawings were made using a camera lucida, and all measurements are given in microns. The measurements of anterior and posterior spines in all cases are given from left to right from the dorsal aspect.

Identification of species was based on standard works on the Rotifera in general (Hudson and Gosse 1886; Donner 1966; Voigt 1957; Bartos 1959; Rudescu 1960; Kutikova 1970) and on the monographs on individual genera (Jennings 1902; Rousselet 1902; Harring and Myers 1926; Ahlstrom 1940, 1943; Bartos 1948, 1950; Wulfert 1965).

Table 1 gives the species of Rotifera recorded in Ontario with localities where each species was collected. A complete list of localities and the species collected in each locality is available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2 in connection with this paper and that of Brandlova *et al.* (1972). For further details see footnote to Table 1.

Results and Discussion

Range of Species in Samples from the Same Habitat

During 1967, two lakes, Sunfish and Paradise Lake, in Waterloo County were sampled weekly. The number of species recorded in each weekly sample is given in Figure 1A. A year round study showed that the maximum number of species appeared in May and minimum in October in these two lakes, thus showing seasonal variation in species composition. In Sunfish Lake a total of 11 species was recorded. The minimum number of species in a sample was one and maximum eight. Similarly, out of 20 species recorded in Paradise Lake the minimum and maximum recorded were 4 and 14, respectively.

In the summer of 1968 weekly samples were taken from two localities, namely Bay of Quinte and Lake Opeongo. The material from Bay of Quinte and Lake Opeongo has yielded 16 and 15 species respectively, as shown in Figures 1A. The maximum number of species recorded in any one sample from the Bay of Quinte was nine and the minimum was four. For Lake Opeongo the number were again nine and four. This observation is very similar to what we obtained in the previous year in regular sampling of Sunfish and Paradise Lakes.

Thus a single sample from a habitat does not give all the species in that habitat. Also there is considerable variation in the percentage of the total number of species in any one sample. Green (1972) has noted a similar relationship between species in a single sample and the total species present. Besides seasonal factors, the method of sampling and the actual location may influence the species distribution, especially in the case of rare species.

Composition of the Ontario Planktonic Rotifera

Rotifera are generally considered to be cosmopolitan in distribution. However, Green (1972) has shown that among planktonic species there is a latitudinal variation of species

FIGURE 1. Distribution of lakes sampled in Ontario. Circles, 1967; closed squares, 1968; triangles, 1969; open squares, 1970; stars mark groups of lakes sampled.

besides cosmopolitan, cosmotropical, arctic–temperate, and American. The Ontario fauna of 53 species and two varieties can be divided on this basis too. The cosmopolitan species found in Ontario number 25. Of the rest only two species, namely *Trichocerca platessa,* Myers and *Brachionus havanaensis* var. *trahea* (Murray) are endemic to the Americas. In all 20 species are endemic to the Americas (Green 1972). The rest of the species are found in the arctic–temperate region. No species is endemic to Canada. *Keratella* is represented by more species than any other genus, a situation universal in the arctic–temperate region. Also,

TABLE 1. — The species of Rotifera recorded in Ontario with examples of localities and their occurrence in our samples

Present Ontario records	No. of our localities	Example of our localities
Asplanchna girodi de Guerne	9	A4, A9, H3
**A. herricki* de Guerne	8	C, H3
A. priodonta Gosse	79	C, D7, H2
Asplanchnopus multiceps (Schrank)	3	A4
Bipalpus hudsoni (Imhoff)	12	H3
Brachionus angularis Gosse	5	A4, C
B. calyciflorus Pallas	4	A4
**B. havanaensis* var. *trahea* (Murray)	1	A4
B. (Platyias) patulus (Müller)	3	A4
B. quadridentatus Hermann	6	A4, A6
**B. urceolaris* Müller	5	A4, A6
Chromogaster ovalis (Bergendal)	2	E7, C2
**Conochiloides exiguus* Ahlstrom	2	C
**C. natans* (Selego)	3	D19, E8
Conochilus hippocrepis (Schrank)	21	F2
C. unicornis Rousselet	44	A4, G, C
Filinia longiseta (Ehrenberg)	18	A4, D8, D13
F. terminalis (Plate)	2	G2, H4
Gastropus stylifer Imhoff	12	C, E5
Hexarthra mira (Hudson)	4	E9, F3
Keratella cochlearis (Gosse)	143	A6, B2, H2
K. cochlearis var. *faluta* Ahlstrom	1	D20
**D. cochlearis* var. *hispida* (Lauterborn)	2	E10
K. crassa Ahlstrom	36	A6, D7
K. earlinae Ahlstrom	25	B3, C
K. hiemalis Carlin	11	A6, A9
K. quadrata (Müller)	49	A4, B2, C
K. serrulata var. *curvicornis* Rylov	5	A4
K. taurocephala Myers	42	B3, D7
Kellicottia bostoniensis (Rousselet)	38	D7, D14, F2
K. longispina (Kellicott)	111	C, D7, D13
Lecane luna (Müller)	7	E7, E9
Lepadella patella (Müller)	1	A6
Monostyla bulla (Gosse)	4	B4, D21
M. lunaris (Ehrenberg)	13	H1
M. quadrindentata (Ehrenberg)	3	A4
Notholca acuminata (Ehrenberg)	12	A6, H1
N. labis Gosse	3	A9
N. squamula (Müller)	5	A4
Ploesoma lenticulare Herrick	9	A6, D13
P. triacanthum (Bergendal)	2	E4
P. truncatum (Levander)	12	C
**Polyarthra dolichoptera* Idelson	33	B2, C
P. euryptera Wierzejski	14	D7
P. vulgaris Carlin	107	A4, C, D7
Pompholyx sulcata Hudson	16	B3
Synchaeta oblonga Ehrenberg	5	A12, D22
S. pectinata Ehrenberg	52	B2, B3, C
S. stylata Wierzejski	5	B13, E5
Testudinella patina	5	A4, H1
Trichocerca cylindrica (Imhoff)	66	C, D7, E4
T. multicrinis Kellicott	20	C, H3
**T. platessa* Myers	10	F4, E7
T. porcellus (Gosse)	2	D7
Trichotria pocillum (Müller)	1	A4
T. tetractis (Ehrenberg)	3	E9

*New record for Ontario.

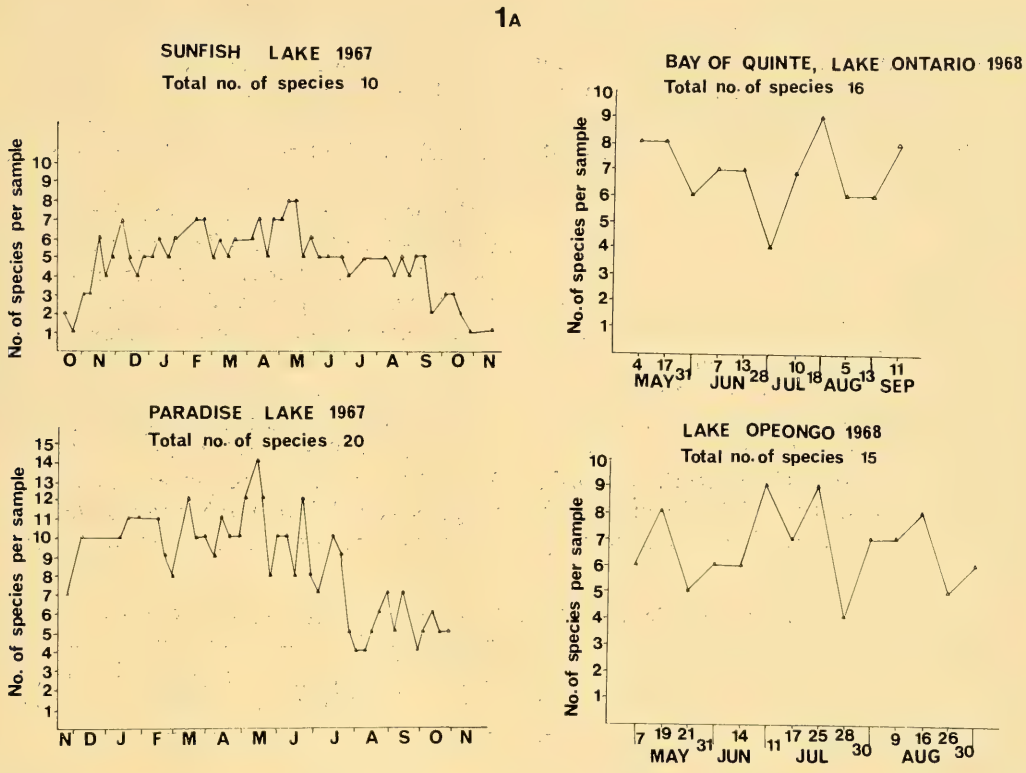

1A
SUNFISH LAKE 1967
Total no. of species 10
No. of species per sample
O N D J F M A M J J A S O N
BAY OF QUINTE, LAKE ONTARIO 1968
Total no. of species 16
No. of species per sample
4 17 MAY 31 7 13 JUN 28 10 JUL 18 5 AUG 13 11 SEP
PARADISE LAKE 1967
Total no. of species 20
No. of species per sample
N D J F M A M J J A S O N
LAKE OPEONGO 1968
Total no. of species 15
No. of species per sample
7 19 21 MAY 31 14 JUN 11 17 25 28 JUL 30 9 16 26 AUG 30

FIGURE 1A. Seasonal variation of rotifer species number in samples from Sunfish Lake and Paradise Lake in Waterloo County, Bay of Quinte (Lake Ontario) and Lake Opeongo, Algonquin Park.

TABLE 1 continued from opposite page.

NOTES: 1. Example of localities arranged by areas given in Figure 1.

Area A:	A4	=	Laurel Creek reservoir, Waterloo; A6 = Pinehurst L.;
	A9	=	Puslinch L.; A12 = Eugenia L.
Area B:	B2	=	Rice L.; B3 = L. Simcoe; B4 = Bass L.
Area C:	C	=	L. Ontario, Bay of Quinte; C2 = Buck L.
Area D:	D7	=	L. Opeongo; D8 = Papineau L.; D13 = Spectacle L.;
	D14	=	Stubbs L.; D19 = Bark L.; D20 = Copps L.; D21 = Aylen L.;
	D22	=	Hogan L.
Area E:	E4	=	Small L.; E5 = Timagami L.; E7 = Beckley L.; E8 = Onwatin L.;
	E9	=	Wanapetei L.; E10 = Houghson L.
Area F:	F2	=	Kirkland L.; F3 = Remi L.; F4 = Kashe L.
Area G:	G	=	Wawong L.; G2 = Mosher L.
Area H:	H1	=	Davy L.; H2 = Gehl L.; H3 = Niobe L.; H4 = Despair L.

2. Supplementary data on all the species recorded in each lake have been placed in the Depository of Unpublished Data, National Research Council of Canada. A master list of all the lakes sampled and dates of sampling by areas (A–H) have also been deposited in the same depository as above in connection with the paper by Brandlova *et al.* (1972; see page 1397). The exact geographical location of the lakes sampled can be obtained from the Gazetteer of Canada: Ontario. Queen's Printer, Ottawa, 1962.

Keratella spp. are the commonest Rotifera in the lakes sampled, occurring in all of them and often being represented by more than one species. *Notholca* spp. and *Kellicottia* spp. are common in Ontario samples. These genera are again well represented in the arctic–temperate region but poorly represented in the tropical region (Green 1972).

Morphological Variation

Considerable morphological variation and the phenomenon of cyclomorphosis are common in planktonic organisms, and are well exemplified by some freshwater rotifers. This type of morphological variation is best known in two common species *Keratella cochlearis* and *Keratella quadrata* (Carlin 1943; Ruttner-Kolisko 1946, 1949; Gallagher 1957; Pejler 1962). Variations have been noted in the present study, especially in the length of the anterior and posterior spines (Tables 2, 3).

Some species in the present material were found to be larger than those previously recorded from more southern localities. The range of total length of species of the genus *Keratella* from Ontario is compared with that of Ahlstrom's (1943) from the United States (Table 4). In the genus *Trichocerca,* our specimens of *T. cylindrica* and *T. platessa* were larger than those previously recorded. The maximum length of the largest previously recorded form of *T. cylindrica* is 680 μ (Bartos 1959), and the largest recorded in the present study is 866 μ. The sizes ranges for length of body given by Bartos (1959) and Rudescu (1960) are 260–320 μ whereas the present material has a range of 282–468 μ. *Trichocerca platessa* found in Ontario is also larger than previously re-

TABLE 2. — Size variation in *Keratella cochlearis* from different localities in Ontario.

Locality	Date	Total length	Width	Length of body	Posterior spine	Anterior spine
Laurel Creek Reservoir	18/6/69	222	63	93	102	21–18–30
Laurel Creek Reservoir	18/5/69	150	59	87	39	18–12–24
Millers Lake	3/11/69	129	54	81	24	15–12–24
Len Lake	30/10/68	192	57	90	69	18–21–30
Little Major Lake	27/5/68	201	48	105	66	33–15–33
Pinehurst Lake	13/5/67	162	57	90	45	21–12–30
Lake Joseph	19/6/67	163	64	83	54	16–13–26
Six Mile Lake	31/7/68	138	51	78	42	21–15–21
Vermilion Lake	28/6/68	180	60	90	60	24–15–30
Sunfish Lake	28/4/71	213	69	102	78	24–18–30
Lake Ontario Bay of Quinte	17/5/68	186	66	93	63	18–15–30

TABLE 3. — Size variation in *Keratella quadrata* from different localities in Ontario.

Locality	Date	Total length	Width	Length of body	Posterior spine	Anterior spine
Laurel Creek Reservoir	18/5/69	258	90	132	90–90	33–30–45
Rainy Lake	27/6/69	394	135	160	148–148	62–49–86
Pinehurst Lake	13/5/67	201	102	123	60–60	33–30–36
Red Lake	6/6/69	330	126	159	135–135	54–51–90
Talbot Lake	20/5/67	307	128	157	99–102	42–38–61
Buck Lake	28/7/67	326	125	150	122–122	43–35–64

TABLE 4. — Size variation in species of *Keratella* from Ontario and more southern localities.

Species	Present study	Ahlstrom's (1943)
K. cochlearis	129–222	119–214
K. taurocephala	225–291	182–270
K. earlinae	192–261	152–251
K. crassa	192–252	140–244
K. quadrata	258–394	172–385

corded by Myers (1934) from the United States. The American forms have a maximum length of 690 μ, the forms found in Ontario measure 775 μ. The reasons for this size difference may be connected with life history patterns.

Ahlstrom (1943) has indicated the varying degree of divergence of the antero-lateral spines in *Keratella taurocephala.* This phenomenon was also noted in the present study and the degree of divergence varied in specimens from different localities and even among specimens from the same sample (Figures 2–4).

Brachionus also shows morphological variation of anterior and posterior spines. In *Brachionus angularis,* the antero-lateral spines were absent in all specimens and sometimes even the intermediate spines were lacking. The cuticular protuberances on either side of the foot opening also varied (Figure 5 and 8).

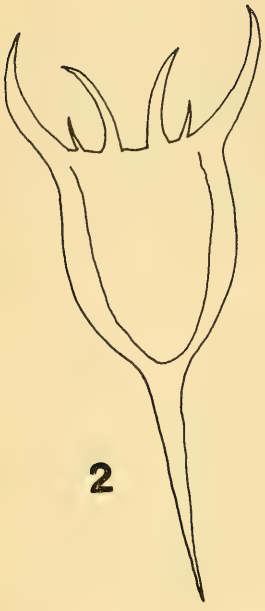
Hitherto unrecorded features in the foundation patterns were noted in the case of *Keratella hiemalis.* In some specimens there was no ridge separating the first median carinal plaque from the median frontal area, but both of them were connected by a short vertical ridge (Figures 7 and 9). The first median carinal plaque therefore appeared more or less triangular.

Pejler's (1962) figures of *Keratella cochlearis* var. *hispida* from central Sweden show markedly hispid loricae. However, in the forms found in Ontario the hispidity, though variable in different specimens, was found not to be as thick as in the European forms, as noted by Ahlstrom (1943) for North American material (Figure 6).

Asplanchna priodonta has a widespread distribution in Ontario. The morphology of the trophi is the chief diagnotic factor. Nevertheless, this shows extreme variation in the position and number of teeth present on the rami. In some the teeth were blunt, while in others they were pointed. Some had wide allulae from the sides of the trophi, and in others small thin projections were discernible. The degree of curvature of the anteriormost teeth also differed in specimens from some localities (Figures 10–15).

The drawings that exist in the literature of the trophi of *Asplanchnopus multiceps* seem to show little detail, though agreeing in general outline with our material (Voigt 1957; Bartos 1959; Rudescu 1960). The fulcrum is very wide and striate, the end of the plate-like flucrum being serrate. Again the basal portion of the rami has a definite sheath with a spine-like projection on the inner side of the rami which may not be visible in some cases since it adheres to the rami dorsally, but is discernible when pressure is applied (Figure 17).

Polyarthra vulgaris and *Polyarthra dolichoptera* were present in more or less equal numbers in some samples, whereas in others *Polyarthra vulgaris* and intermediate forms which did not fall into the typical *Polyarthra vulgaris* or *Polyarthra dolichoptera* types were present. Carlin (1943) was the first to mention that he had found such intermediate forms. Bartos (1950) did not mention introgressive forms in his monograph of *Polyarthra,* nor did Nipkow (1952) in his paper on *Polyarthra* from a lake in Zurich. Pejler (1956) was the first to study introgression in detail. He found some cases where typical specimens of *Polyarthra vulgaris* and *Polyarthra dolichoptera* were found with forms transitional between the two. In other cases typical individuals of *Polyarthra vulgaris* occurred with intermediate forms, but without "typical" specimens of *Polyarthra dolichoptera.* In still other cases, Pejler (1956) observed only intermediate forms. Usually the intermediate forms occupy a transitional position with regard to many of the characters which distinguish the two species. The fins of the introgressive forms observed were not of the *Polyarthra vulgaris* or *Polyarthra dolichoptera* type, but transitional. Again the lateral antennae were situated in such a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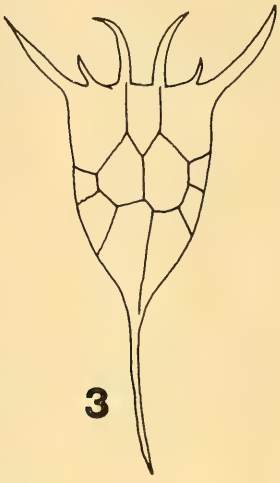
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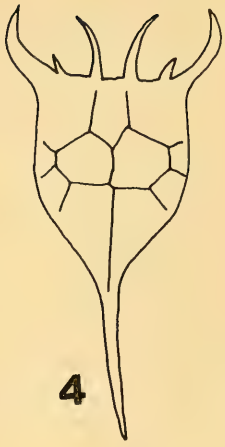
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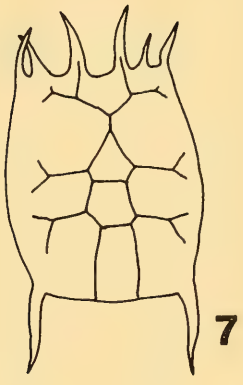
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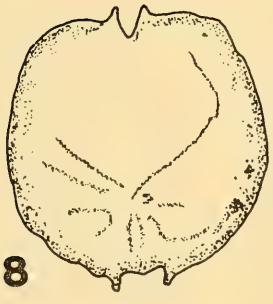
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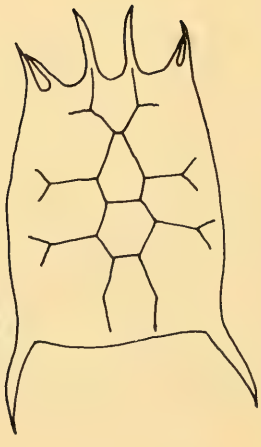
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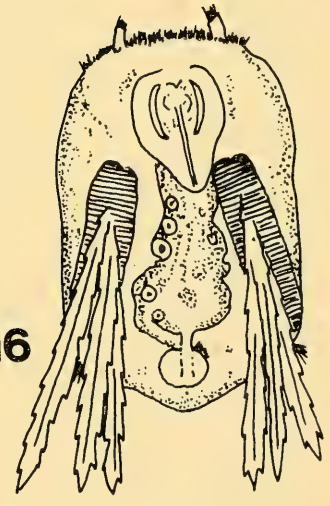
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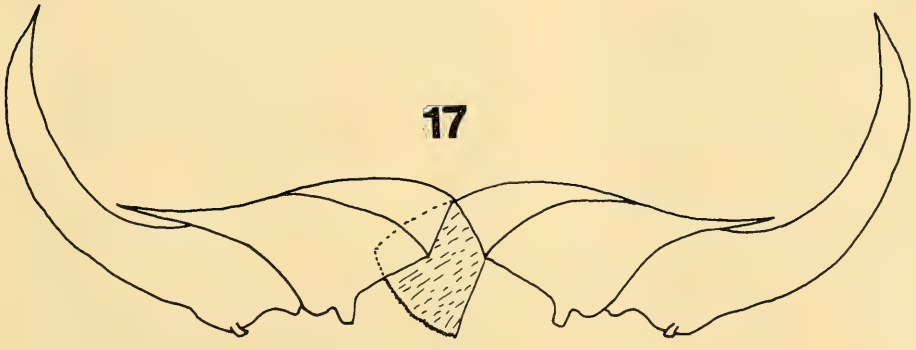
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position that it was hard to say whether they were lateral or on the corner where the sides merge into the posterior end. Judged from the work of Pejler (1956, 1957), our specimens are introgresive forms.

Forms intermediate between *Conochilus unicornis* and *Conochilus hippocrepis* have been reported (Pejler 1956). However, in the present study no introgresive forms of *Conochilus* were found.

The diagnostic characters for the identification of the species in the genus *Polyarthra* have been questioned by many workers (Sudzuki 1964; Ruttner-Kolisko 1959). Nipkow (1952) used the appearance of the resting eggs and the number of nuclei in the vitellarium as taxonomic criteria. However, as Ruttner-Kolisko (1959) pointed out, the resting eggs are seldom available for examination, especially in preserved material. Regarding the number of nuclei in the vitellarium, the constancy of this number is questioned by Sudzuki (1955) in his work on *Polyarthra trigla* Ehrenberg. In *Polyarthra euryptera* one of the characters for identification is the number of nuclei in the vitellarium, which is given as 12 (Carlin 1943; Bartos 1950; Nipkow 1952; Sudzuki 1964). However, in a number of specimens we examined, the number of nuclei in the vitellarium was found to vary from 10 to 13, the majority of the specimens having 11 or 12 nuclei. This indicates that the number of nuclei in the vitellarium has little value as a taxonomic character in the identification of species in the genus *Polyarthra*.

Ruttner-Kolisko (1959) has observed throat pouches for many of the specimens of *Polyarthra dolichoptera* that she examined from the Kapruner reservoir. *Polyarthra proloba* is distinguished by the throat pouch. However, Ruttner-Kolisko see little difference between *Polyarthra proloba* and *Polyarthra dolichoptera* which has developed a throat pouch. The throat pouch has also been noticed in *Polyarthra vulgaris* and *Polyarthra remata* (Ruttner-Kolisko 1959). In some of the specimens of *Polyarthra dolichoptera* that we examined during the present study a clear throat pouch has been observed (Figure 16).

The insertion of the posterior seta is of taxonomic importance in identifying the species of *Filinia* (Pejler 1957; Hutchinson 1964). Hutchinson (1964) states that the insertion of the posterior seta of *Filinia terminalis*, if not terminal, is usually less than 10 μ from the posterior end of the body. Pejler (1957) observed some specimens in Sweden with the posterior seta inserted up to 28 μ in front of the posterior end. In a number of specimens examined by the authors, it was found that the insertion of the posterior seta was in the range of 5 to 32 μ from the posterior end. The shape of the body of *Filinia longiseta* and *Filinia terminalis* did not show any recognizable difference in the preserved state.

Acknowledgments

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Literature Cited

Ahlstrom, E. H. 1940. A revision of the Rotatorian genus *Brachionus* and *Platyias* with descriptions of one new species and two new varieties. Bulletin of the American Museum of Natural History 77: 143–184.

Ahlstrom, E. H. 1943. A revision of the Rotatorian genus *Keratella* with descriptions of three new species and five new varieties. Bulletin of the American Museum of Natural History 80: 411–457.

Anderson, D. V. and **D. Clayton.** 1959. Plankton in Lake Ontario. Ontario Department of Lands and Forests Physical Research Note 1: 1–47.

Bartos, E. 1948. The Bohemian species of genus *Pedalia* Barrios with the key of determining of all known species of this genus. Zvlaštùi Otisk z Casopisu Narodního Musea, Oddil Přivodovědný 37.

Bartos, E. 1950. Klič kurcovani viřniků rodu *Polyarthra* Ehrenberg. Casopis Narodního Oddil Privodovědný 118: 82–91.

Bartos, E. 1959. Vířníci-Rotatoria. Nakladatelstvi Ceskoslovenske Akademie Věd Praha. 969 pp.

Bigelow, N. K. 1923. The plankton of Lake Nipigon and environs. University of Toronto Studies 13: 39–66.

Brandlova, J., Z. Brandl and **C. H. Fernando.** 1972. The Cladocera of Ontario with remarks on some species and distribution. Canadian Journal of Zoology 50: 1373–1403.

FIGURES 2–9. FIGURES 2–4. *Keratella taurocephala,* showing the difference in the degree of divergence of the antero-lateral spines. FIGURES 5,8. *Brachionus angularis,* showing variation in the shape of lorica. FIGURE 6. *Keratella cochlearis* var. *hispida.* FIGURES 7,9. *Keratella hiemalis,* showing the foundation pattern.

FIGURES 10–17. FIGURES 10–15. Trophi of *Asplanchna priodonta* showing variations. FIGURE 16. *Polyarthra dolichoptera.* FIGURE 17. Trophi of *Asplanchnopus multiceps.*

Carlin, B. 1943. Die Planktonrotatorien des Motalastrom. Zur Taxonomie und Okologie der Planktonrotatorien. Meddelanden Frau Lunds Universitets Limnologiska Institution 5: 1–255.

Chengalath, R. 1971. Systematics and distribution of limnetic Rotifera of Ontario. M.Sc. Thesis, University of Waterloo, Waterloo, Ontario. 124 pp.

Chengalath, R., C. H. Fernando, and **M. G. George.** 1972. The planktonic Rotifera of Ontario with keys to genera and species. University of Waterloo Biology Series No. 2. 40 pp.

Davis, C. C. 1969. Seasonal distribution, constitution and abundance of zooplankton in Lake Eries. Journal of the Fisheries Research Board of Canada 26: 2459–2476.

Donner, J. 1966. Rotifers. Frederick Warne and Company Limited, London, England. 80 pp.

Gallagher, J. J. 1957. Cyclomorphosis in the rotifer *Keratella cochlearis* Gosse. Transactions of the American Microscopical Society 76: 197–203.

George, M. G. and **C. H. Fernando.** 1969a. Seasonal distribution and vertical migration of planktonic rotifers in two lakes in Eastern Canada. Verhandelungen Internationalis Vereinigung Limnologie 17: 817–829.

George, M. G. and **C. H. Fernando.** 1969b. On the rotifer *Keratella canadensis* (Berzins). Canadian Journal of Zoology 47: 155–156.

Green, J. 1972. Latitudinal variation in associations of Planktonic Rotifera. Journal of Zoology (London) 167: 31–39.

Harring, H. K. and **F. J. Myers.** 1926. The rotifer fauna of Wisconsin. III. A revision of the genera *Lecane* and *Monostyla.* Transactions of the Wisconsin Academy of Sciences, Arts and Letters 22: 315–423.

Hudson, C. T. and **P. H. Gosse.** 1886. The Rotifera, or Wheel animalcules. Longman, Green and Company, Volume I, p. 128; Volume II, p. 144. London.

Hutchinson, G. E. 1964. On *Filinia terminalis* (Plate) and *Filinia Pejleri* sp. n. (Rotatoria: Family Testudinellidae). Postilla-Peabody Museum of Natural History 81: 18–23.

Jennings, H. S. 1902. Rotatoria of the United States. II. A monograph of the Rattulidae. Bulletin of the United States Fish Commission 1902: 272–352.

Kutikova, L. A. 1970. (Kolavratki) Rotifer fauna SSSR. Sub-class Eurotatoria. Nauka, Leningrad. (In Russian.) 742 pp.

Mackay, H. H. 1951. The net plankton of Lake Nipigon. Abstract of Doctoral thesis, University of Toronto, Toronto, Ontario. 82 pp.

Myers, F. J. 1934. The distribution of Rotifera on Mount Desert Island. Part V. A new species of Asplanchnidae, Trichocercidae and Brachionidae. American Museum Novitates 700: 1–16.

Myers, F. J. 1937. A method of mounting rotifer jawl for study. Transactions of the American Microscopical Society 56: 256–257.

Myers, F. J. 1942. The rotatorian fauna of Pocono plateau and environs. Proceedings of the Academy of Natural Sciences Philadelphia 94: 251–285.

Murray, J. 1911. Canadian Rotifera: collected by the Shackleton Antarctic Expedition, 1909. Journal of the Royal Microscopical Society: 285–297.

Nipkow, F. 1952. Die Gattung *Polyarthra* Ehrenberg in Plankton des Zurichsees und einiger anderer Schweizer Seen. Schweizerische Zeitschrift Hydrologie 14: 135–181.

Odell, W. S. and **W. E. Harris.** 1933. Rotifera of Ottawa and district. Canadian Field Naturalist 47: 132–133.

Pejler, B. 1956. Introgression in planktonic rotatoria with some points of view on its causes and conceivable results. Evolution 10: 246–261.

Pejler, B. 1957. Taxonomical and ecological studies on planktonic rotatoria from Northern Swedish Lapland. Kungliga Svenska Vetenskapsakademiens Handlingar 5: 1–67.

Pejler, B. 1962. On the variation of rotifer *Keratella cochlearis* (Gosse). Zoologiska Bidrag Frau Uppsala 35: 1–17.

Rousselet, C. F. 1902. The genus *Synchaeta.* Journal of the Royal Microscopical Society 192: 269–411.

Rudescu, L. 1960. Rotatoria. Editure Academic Republicii Populare Romine. 1188 pp.

Ruttner-Kolisko, A. 1946. Uber das auftreten Unbefruchtete, Dauereier bei *Anuraea aculeata (Keratella quadrata).* Osterreichische Zoologische Zeitschrift 1: 179–191.

Ruttner-Kolisko, A. 1949. Zum Formwechsel- und Artproblem von *Anuraea aculeata (Keratella quadrata).* Hydrobiologia 1: 425–468.

Ruttner-Kolisko, A. 1959. Uber die Populationen der *Polyarthra dolichoptera.* Idelson (Rotatoria) in den Kapruner Stauseen. Anzeiger der Osterreichischen Akademie der Wissenchaften Mathematisch naturwissenschaftliche Klasse 1: 4–9.

Sudzuki, M. 1955. Life history of some Japanese rotifers 1. *Polyarthra trigla* Ehrenberg. Science Report of the Tokyo Kyoiku Daigaku 8: 41–64.

Sudzuki, M. 1964. New systematical approach to the Japanese planktonic Rotatoria. Hydrobiologia 23: 1–124.

Voigt, M. 1957. Rotatoria, die Radertiere Mitteleuropas. Gebruder Borutraeger, Berlin-Nikolasse. 508 pp.

Wulfert, K. 1965. Revision der Rotatorian-Gattung *Platyias* Harring 1913. Limnologica (Berlin) 31: 41–64.

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Spatial Distribution and "Effective" Breeding Population of Red-legged Frogs (*Rana aurora*) in Marion Lake, British Columbia

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Calef, G. W. 1973. Spatial distribution and "effective" breeding population of red-legged Frogs (*Rana Aurora*) in Marion Lake, B.C. Canadian Field-Naturalist 87: 279-284.

Abstract. During the springs of 1969 and 1970 male red-legged frogs (*Rana aurora*) were captured from breeding choruses in Marion Lake, British Columbia and marked individually by toe-clipping. Subsequent recaptures allowed an estimation of the number of breeding males and their movements between weedbeds. The total number of egg clutches produced by the frog population was also determined.

Male frogs did not defend, or remain in, a specific area throughout the breeding season. Some males which moved from one area of the lake to another were successful in mating. There was a tendency for males to return to the same area of the lake in 1970. Only a fraction of the potential male breeding population reproduces each year.

Introduction

Recent studies on the breeding aggregations of certain temperate-zone frogs have revealed the existence of territorial and agonistic behaviour (Emlen 1968) and an "effective" breeding population which is substantially less than the observed total population (Merrell 1968). The importance of these observations for theories of population regulation and evolution suggests that such studies should be extended to other populations of anurans.

This paper reports observations made on the breeding aggregations of the red-legged frog *Rana aurora* during the springs of 1969 and 1970 in Marion Lake, British Columbia (see Efford (1967) for a detailed description of the lake). Special attention was paid to the movements of male frogs during the breeding season and to the relationship between the numbers of potentially breeding adults and the actual numbers of egg masses produced by the population.

Methods

Licht (1969) has described some aspects of the breeding behavior of *R. aurora* at several locations in southwestern British Columbia. The most striking feature of the breeding chorus is that the males call under water, often at depths of several meters. Therefore, I made my observations from a row-boat equipped with tractor headlights, which shone vertically down into the water. On nine nights I visited the submerged weedbeds (*Potamogeton natans* or *Isoetes occidentalis*) where most of the calling and egg-laying took place (Figure 1A). The calling males were captured with dip nets, individually toe-clipped, and released immediately.

Sampling was done on nine dates in each of 1969 and 1970 as indicated in Tables 1 and 2. Prior to capture, the spatial relationship of males was observed. Toe-clipping allowed me to estimate the population of males by means of a mark–recapture procedure, to follow their movements from weedbed to weedbed, and to record the reproductive activities of specific males later captured in amplexus.

In early May, long after the frogs left the lake, I determined the numbers and distribution of egg masses by systematically searching the entire lake. To aid in this search, I divided the lake into 1000 m^2 quadrats by placing an

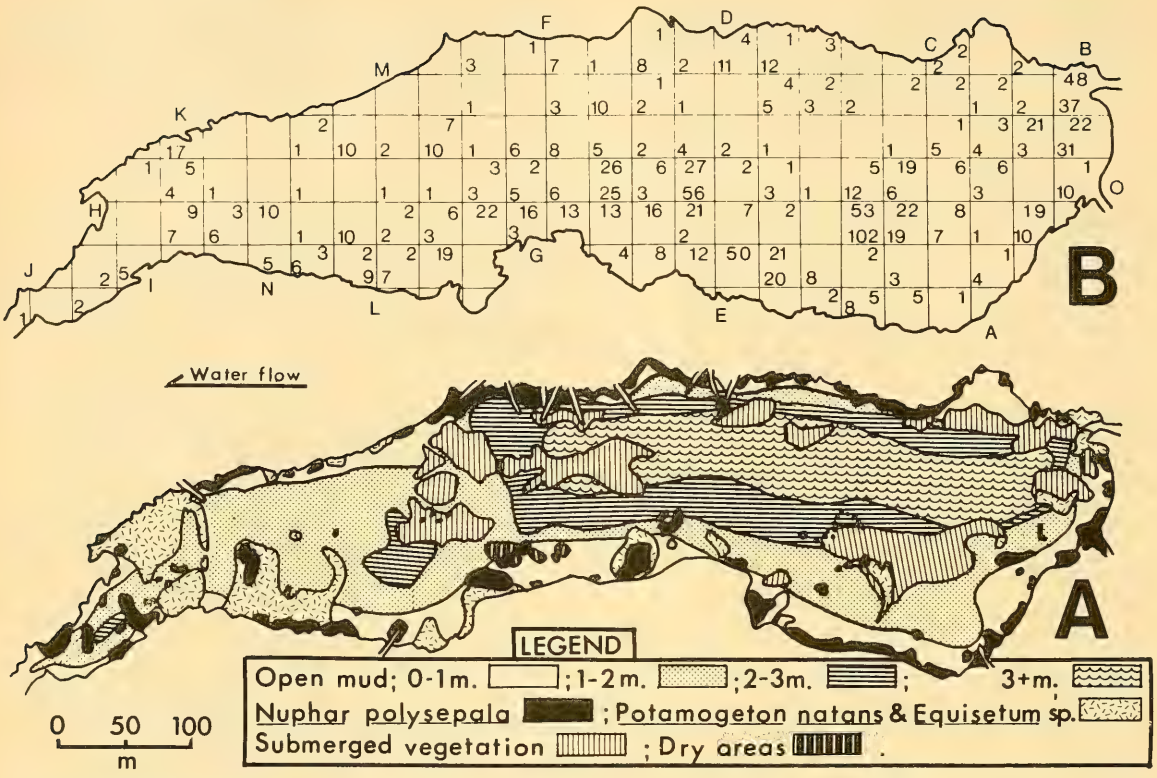

FIGURE 1A (Lower map). Map of the seven "sub-habitats" defined for the bottom of Marion Lake. The areas termed "submerged vegetation" supported some of the following species: *Chara globularis, Isoetes occidentalis,* and *Potamogeton epihydris.* The "open mud" habitats were defined in terms of the depth of water covering them.

FIGURE 1B (Upper map). Distribution of egg masses in Marion Lake in 1969 and 1970. The number in the upper right-hand corner of each quadrat indicates the number of egg masses found in that quadrat in 1969; the lower left-hand number indicates masses found in 1970. The quadrats shown are 1000 m^2.

anchored buoy at the corners of each quadrat. The shallow areas (less than 1 m in depth) were searched from a boat and each egg mass was marked with a stake. I searched the deeper areas by diving, and a systematic pattern was assured by following a boat which was rowed back and forth through the quadrat. The clarity of the water, the sparseness of the vegetation, and the large size (approximately 15 cm diameter) and opacity of the egg masses suggest that very few egg masses were missed. There is no species of plant in Marion Lake which is capable of obscuring an egg mass of the size laid by *Rana aurora.* Complete recounts of selected quadrats in both deep and shallow water resulted in identical counts except in cases in which waves or other agencies had caused a mass to break loose and drift away, as evidenced by a marker with no accompanying egg mass. This may have resulted in some masses' being counted twice, but the frequency of masses disappearing was very low (less than 5% of the total).

The population of breeding males was estimated from the recapture data, by the maximum likelihood method (Kendall and Stuart 1958). For each sampling date after the first of each year, the probability of marked and

unmarked animals in the population is expressed as X/N and $1-X/N$ respectively where X is the number of marked animals which have been released in the population prior to that sampling date, and N is the population size. From these probabilities, the likelihood of obtaining the observed sample (of marked to unmarked animals) for each date is then calculated. By trial and error on the computer, the value of N which maximizes the product of these likelihoods is calculated as the best estimate of the population, and the standard error is calculated in a similar way.

This method of estimation assumes that no immigration, emigration, or mortality is occurring. The assumptions regarding immigration and emigration seem justified because

(1) the sampling was not begun until egg masses appeared in the lake. Thus, most males which were involved in breeding must have been in the lake by this time, especially since the breeding season is so short in this species. Most of the eggs are laid during a period of 10 days to 2 weeks. Thus immigration seems unlikely.

(2) animals which were captured early in the sampling period (e.g. dates 1, 2, or 3) continued to appear in the samples until the final period. It seems reasonable to me that if emigration were occurring, it would be the animals that were in the lake earliest that would leave earliest. Thus I rule out emigration. Mortality is considered negligible because of the short period involved, and the scarcity of vertebrate predators at this time. The only common vertebrate predators at Marion Lake, the garter snake (*Thamnophis sertalis*) and the great blue heron (*Ardea herodias*) are not active at this time of year.

Results and Discussion

Licht's (1969) description of *R. aurora* breeding aggregations are applicable, with two exceptions, to the Marion Lake population. Licht states "water temperature of 7°C is sufficient for spawning" and that "once this minimum is reached, most eggs are deposited." At Marion Lake frogs call and breed at water temperatures between 4°C and 5°C, and many times males were observed calling under a skim of ice. The number of males calling appeared to be slightly reduced on these cold nights, but egg-laying still occurred. The eggs remain in water of less than 5°C for many days during the spring. Egg-laying in Marion Lake occurs at all depths from a few inches to 5 m, the maximum depth found in the lake, and not just "up to 5 feet," as stated by Licht.

The numbers of egg masses laid by the population in 1969 and 1970 were 618 and 620 respectively, and were distributed in the lake as shown in Figure 1B.

The numbers of frogs marked and recaptured during the study are shown in Tables 1 and 2. The successive population estimates are shown in the bottom row. The overall maximum likelihood estimates for breeding males were 1770 $\pm$ 280 (Standard Error) in 1969, and 3600 $\pm$ 775 (Standard Error) in 1970.

Females were captured much less frequently than males (fewer than 10% of frogs captured were females) and all females captured were in amplexus. Thus, females must mate almost immediately upon entering an area where males are calling, and unlike the males, they do not remain in the lake after amplexus. Consequently, no population estimate was attempted for the females.

The substantial difference between the numbers of egg masses laid and the numbers of males estimated (618 egg masses vs. 1770 males in 1969, and 620 vs. 3600 in 1970) could be due either to an unequal sex ratio (with more males than females) or to some mechanism by which a large fraction of the adult males or adults of both sexes are excluded from breeding. The "effective" breeding population, that is, the number of adults actually contributing to the next generation, was less than would have been supposed from an estimate of the adult male population. Many males clearly failed to breed. Merrell (1968) gave a good discussion of the importance in evolutionary theory of distinguishing between the number of potentially breeding adults in a population and the actual number contributing to the next generation.

TABLE 1. — Population data for breeding male red-legged frogs for 1969.

	Capture dates								
	April								
	4	5	7	9	10	11	14	15	18
Dates of previous capture									
April									
4	27	0	4	0	2	0	1	1	0
5		42	5	2	1	2	0	1	0
7			78	1	2	4	0	1	1
9				61	1	2	0	0	0
10					34	0	0	0	0
11						37	0	1	0
14							14	0	0
15								36	1
18									15
Number marked	0	0	9	3	6	8	1	4	2
Number unmarked	27	42	78	61	34	37	14	36	15
Number released	27	42	87	64	40	45	15	40	17
Number marked in population	27	69	147	208	242	279	293	329	344
Population estimate	–	–	667	3136	1386	1361	4185	2980	2790

TABLE 2. — Population data for breeding male red-legged frogs for 1970.

	Capture dates								
	February						March		
	22	23	24	25	26	28	9	13	17
Dates of previous capture									
February									
22	54	3	2	1	0	0	2	0	1
23		77	1	0	0	2	0	1	0
24			55	1	0	0	0	2	0
25				59	1	0	1	0	2
26					19	0	0	0	0
28						11	0	0	0
March									
9							48	0	0
13								24	0
17									39
Number marked	0	3	3	2	1	2	3	3	3
Number unmarked	54	77	55	59	19	11	48	24	39
Number released	54	81	58	61	20	13	51	27	41
Number marked in population	54	135	193	254	274	287	338	365	406
Population estimate	–	1485	2610	5886	5080	1781	4879	3042	4988

I may have altered the behavior of the frog population, but I doubt it because (1) only 10–15% of the estimated population was captured and marked during the study each year, (2) males that were captured and marked were found later in amplexus, (3) the number of egg masses in 1969 and 1970 did not differ significantly from the number found in 1968, when the breeding aggregations were not disturbed, and (4) only a short period was spent each evening in any given area of the lake. Hydrophone observations made by Licht (personal communication) indicated that at least some of the frogs within a weedbed continued to call even when the boat was present.

The small sample (seven females, five males) of frogs caught in the vicinity of Marion Lake during the summer of 1969 is not adequate to establish a sex ratio for the population. Merrell (1968) in his study of leopard frogs (*Rana pipiens*) found equal sex ratios away from the breeding ponds, but many fewer egg masses than males in the breeding populations. He did not mention the possibility that females do not breed every year. If females required more than one year to produce mature eggs, then there would be more males than females in the breeding pond, but not at other times of the year. There is no evidence on this point from my study. However, Licht (personal communication) has found that in another population of *R. aurora* near Vancouver, at least some of the females develop a new clutch of eggs each year.

The frogs recaptured in my study were often found in locations distant from their place of original capture. In fact, animals often moved from one type of weedbed to another, e.g. from *Potamogeton* to *Isoetes,* and from one depth to another. Of the 34 frogs recaptured in 1969, 23 were found in weedbeds different from the one in which they were first captured. Three of these frogs moved less than 100 m, 14 moved 100–300 m, and six moved more than 300 m. In 1970, of the 24 recaptured, 13 moved less than 100 m, two moved 100–300 m, and three others moved more than 300 m.

Twenty-five males were captured in amplexus in 1969. Three of these had previously been captured in another weedbed, four were recaptured up to 3 days after having been marked while in amplexus, and one frog was captured in amplexus twice with a different female each time. Thus, frogs which move away from a given area can still take part in breeding.

Sixty-six frogs marked during the 1969 season were recaptured in 1970. Of these recaptures, 38 had returned to the weedbed where they had been captured a year earlier while nine others were less than 100 m away from the area of previous capture. Thus, males had a tendency to return to a particular area of the lake.

No displays of aggressive behavior between males were noted. The spatial distribution between frogs was not the relatively even spacing which one associates with territorial behavior in other vertebrates. Often several males were clustered within inches of each other, while others were several feet apart. On one occasion five males were captured in amplexus with one female. Such interference with the mating of an individual would not be expected in a territorial species. Indeed, protection from interference with mating is one of the functions commonly attributed to territoriality (Hinde 1956).

Although males mostly aggregated in the major weedbeds, isolated males were often observed near logs, sticks, or lily pads in the open mud areas. The fact that egg masses were often found in these localities suggests that some of these isolated males must have bred.

Conclusions

The above observations suggest the following conclusions:

(1) males of *Rana aurora* do not defend or remain in a specific territory throughout the breeding season. Males which move from one area to another can still be successful in mating. However, there is a tendency for males to return to a given area of the lake each year;

(2) male frogs do not leave the lake immediately after mating and may mate more than once;

(3) apparently only a fraction of the potential male breeding population mates each year.

Thus, there may exist in some *R. aurora* populations a social or physiological mechanism which prevents some potential breeding males from mating, but this mechanism does not involve an aggressively defended territory.

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Literature Cited

Efford, I. E. 1967. Temporal and spatial differences in phytoplankton productivity in Marion Lake, British Columbia. Journal of the Fisheries Research Board of Canada 24(11): 2283–2307.

Emlen, S. T. 1968. Territoriality in the bullfrog, *Rana catesbeiana*. Copeia 1968: 240–243.

Hinde, R. A. 1956. The biological significance of the territories of birds. Ibis 98: 340–369.

Kendall, D. G. and **A. Stuart.** 1958. The advanced theory of statistics. Griffin, London.

Licht, L. E. 1969. Comparative breeding behaviour of the red-legged frog (*Rana aurora aurora*) and the western spotted frog (*Rana pretiosa pretiosa*) in south-western British Columbia. Canadian Journal of Zoology 47: 1287–1299.

Merrell, D. S. 1968. A comparison of the estimated size and the "effective size" of breeding populations of the leopard frog, *Rana pipiens*. Evolution 22: 274–283.

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Studies on the Bryophytes of Southern Manitoba. IV. Collections from Bird's Hill Provincial Park

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Stringer, P. W. and M. H. L. Stringer. 1973. Studies on the bryophytes of southern Manitoba. IV. Collections from Bird's Hill Provincial Park. Canadian Field-Naturalist 87: 285-290.

Abstract. One hundred and seventeen taxa of bryophytes were collected in Bird's Hill Provincial Park, Manitoba. Habitats sampled included ditches, streams, marshes, moist clay banks, dry grassland, and areas forested by black spruce, tamarack, white cedar, white spruce, aspen, balsam poplar, and bur oak. *Cephalozia catenulata, Platydictya confervoides, P. subtile,* and *Thuidium minutulum* are new records for the province.

Introduction

Bird's Hill Provincial Park lies approximately 24 kilometers northeast of downtown Winnipeg. Approximately 36 square kilometers in extent, it is bounded on all sides by private, usually partly developed land. Much of the central upland part of the park, which had already been cleared and farmed before establishment of the park in 1964, has now been developed for recreational purposes.

Bird's Hill itself, occupying most of the park, rises about 30 kilometers above the surrounding alluvial plain. It consists of coarse-textured glacio-fluvial deposits on limestone and dolomite, and was formerly an island in glacial Lake Agassiz (Ehrlich et al. 1953).

A considerable part of the park is occupied by scrubby aspen–oak forest (*Populus tremuloides*[2] – *Quercus macrocarpa*), with jack pine only occasional on the coarse glacial till of the upland areas. Interspersed in this forest are small areas of prairie and scrub, sometimes of fire origin. Coniferous forest is only a minor constituent of the park vegetation. In the wet, poorly-drained depressions, especially in the western and northern parts of the park, black spruce (*Picea mariana*) and tamarack (*Larix laricina*) forest has developed on deep layers of peat. Much of the northern area is inaccessible because of excessive wetness. White spruce (*Picea glauca*) occurs in isolated areas of mixedwood on better drained but periodically wet sites, and occasionally on well-drained upland sites. White cedar (*Thuja occidentalis*) occurs as small, isolated populations on mesic-wet sites in the western part of the park.

[2]Vascular plant nomenclature follows Scoggan (1957).

The only bryophyte previously recorded for the park is "*Sphagnum* moss" (National Audubon Society 1966). However, a study of the distribution of terrestrial bryophytes in a black spruce bog has been made by the authors (Stringer and Stringer, 1973).

The present study was carried out chiefly in May and June 1972. Collections were made at 35 sites (Figure 1). Much of the northern part of the park remained flooded throughout the summer, and site 11 (Figure 1) was the only part of this area that could be visited. Collections from site 11 were made in late August.

Bryophytes Collected

A total of 117 taxa were collected from Bird's Hill Provincial Park; these are listed. Nomenclature of the Eubrya and Sphagnobrya follows Crum et al. (1965). Nomenclature of Mniaceae follows Koponen (1968, 1971). Hepatic nomenclature follows Schuster (1953, 1966, 1969), with abbreviations of authorities modified to conform with the list of Sayre et al. (1964).

Hepaticae
Blepharostoma trichophyllum (L.) Dum.
Cephalozia catenulata (Hüb.) Spruce
Cephalozia media Lindb.
Cephaloziella rubella (Nees) Warnst.
Chiloscyphus pallescens (Ehrh.) Dum.
Chiloscyphus polyanthus (L.) Corda
Frullania eboracensis Gott.
Jamesoniella autumnalis (DC.) Steph.
Lophocolea bidentata (L.) Dum.

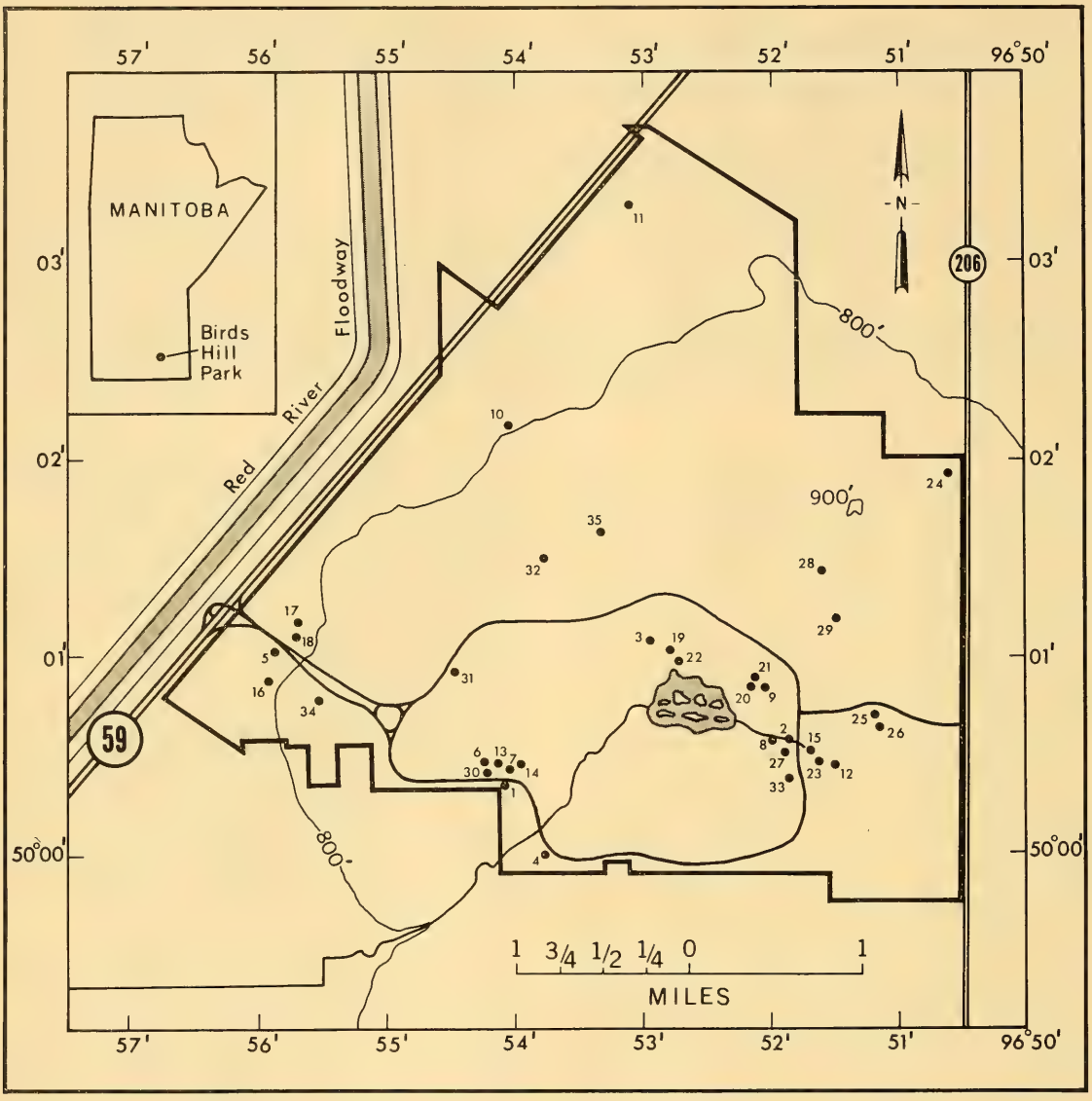

FIGURE 1. Bird's Hill Provincial Park, Manitoba, showing locations of collecting sites 1–35.

Lophocolea heterophylla (Schrad.) Dum.
Lophocolea minor Nees
Marchantia polymorpha L.
Porella platyphylla (L.) Lindb.
Ptilidium ciliare (L.) Nees
Ptilidium pulcherrimum (Web.) Hampe
Radula complanata (L.) Dum.
Riccardia latifrons (Lindb.) Lindb.
Riccardia palmata (Hedw.) Carruth.
Riccardia pinguis (L.) S. Gray

Sphagnobrya
Sphagnum capillaceum (Weiss) Schrank
Sphagnum squarrosum Sw. *ex* Crome

Eubrya
Amblystegium juratzkanum Schimp.
Amblystegium serpens (Hedw.) B.S.G.
Amblystegium varium (Hedw.) Lindb.
Aulacomnium palustre (Hedw.) Schwaegr.
Astomum muehlenbergianum (Sw.) Grout
Barbula convoluta Hedw.
Barbula fallax Hedw.
Barbula unguiculata Hedw.
Brachythecium acuminatum (Hedw.) Rau and Herv.
Brachythecium campestre (C. Müll.) B.S.G.
Brachythecium collinum (Schleich. *ex* C. Müll.) B.S.G.
Brachythecium rutabulum (Hedw.) B.S.G.

Brachythecium salebrosum (Web. and Mohr) B.S.G.
Brachythecium starkei (Brid.) B.S.G.
Brachythecium velutinum (Hedw.) B.S.G.
Bryoerythrophyllum recurvirostrum (Hedw.) Chen.
Bryum angustirete Kindb. *ex* Mac.
Bryum argenteum Hedw.
Bryum caespiticium Hedw.
Bryum creberrimum Tayl.
Bryum pallescens Schleich. *ex* Schwaegr.
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer and Scherb.
Bryum stenotrichum C. Müll.
Callicladium haldanianum (Grev.) Crum
Calliergon giganteum (Schimp.) Kindb.
Campylium chrysophyllum (Brid.) J. Lange
Campylium hispidulum (Brid.) Mitt.
Campylium stellatum (Hedw.) C. Jens.
Ceratodon purpureus (Hedw.) Brid.
Climacium dendroides (Hedw.) Web. and Mohr
Dicranella schreberiana (Hedw.) Schimp.
Dicranella varia (Hedw.) Schimp.
Dicranum polysetum Sw.
Distichium capillaceum (Hedw.) B.S.G.
Drepanocladus aduncus (Hedw.) Warnst.
Drepanocladus aduncus (Hedw.) Warnst. var *kneiffii* (B. S. G.) Mönk.
Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. *ex* Voit) Roth
Drepanocladus fluitans (Hedw.) Warnst.
Drepanocladus revolvens (Sw.) Warnst.
Drepanocladus sendtneri (Schimp.) Warnst.
Drepanocladus uncinatus (Hedw.) Warnst.
Encalypta procera Bruch
Eurhynchium pulchellum (Hedw.) Jenn.
Fissidens osmundioides Hedw.
Funaria hygrometrica Hedw.
Grimmia alpicola Hedw.
Grimmia apocarpa Hedw.
Haplocladium microphyllum (Hedw.) Broth.
Hedwigia ciliata (Hedw.) P. Beauv.
Helodium blandowii (Web. and Mohr) Warnst.
Hylocomium splendens (Hedw.) B. S. G.
Hypnum cupressiforme Hedw.
Hypnum cupressiforme Hedw. var. *resupinatum* (Wils.) Schimp.
Hypnum lindbergii Mitt.
Hypnum pallescens (Hedw.) P. Beauv.
Hypnum pratense Koch *ex* Spruce
Hypnum revolutum (Mitt.) Lindb.
Isopterygium turfaceum (Lindb.) Lindb.
Leptobryum pyriforme (Hedw.) Wils.
Leptodictyum brevipes (Card. and Thér. *ex* Holz.) Broth.
Leptodictyum riparium (Hedw.) Warnst.
Leptodictyum trichopodium (Schultz) Warnst.
Leptodictyum trichopodium (Schultz) Warnst. var. *kochii* (B. S. G.) Broth.
Leskea polycarpa Hedw.
Mnium spinulosum B. S. G.
Myurella julacea (Schwaegr.) B. S. G.
Oncophorus wahlenbergii Brid.
Orthotrichum obtusifolium Brid.
Orthotrichum pumilum Sw.
Orthotrichum speciosum Nees *ex* Sturm
Philonotis fontana (Hedw.) Brid.
Physcomitrium pyriforme (Hedw.) De Not.
Plagiomnium cuspidatum (Hedw.) Kop.
Plagiomnium drummondii (Bruch and Schimp.) Kop.
Plagiomnium rostratum (Schrad.) Kop.
Plagiomnium rugicum (Laur.) Kop.
Plagiothecium denticulatum (Hedw.) B. S. G.
Platydictya confervoides (Brid.) Crum
Platydictya subtile (Hedw.) Crum
Platygyrium repens (Brid.) B. S. G.
Pleurozium schreberi (Brid.) Mitt.
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. and Mohr) Andr.
Polytrichum juniperinum Hedw.
Ptilium crista-castrensis (Hedw.) De Not.
Pylaisiella polyantha (Hedw.) Grout
Rhodobryum roseum (Hedw.) Limpr.
Rhynchostegiella compacta (C. Müll.) Loeske
Tetraphis pellucida Hedw.
Thuidium delicatulum (Hedw.) B. S. G.
Thuidium delicatulum (Hedw.) B. S. G. var. *radicans* Crum, Steere and Anderson
Thuidium minutulum (Hedw.) B. S. G.
Thuidium recognitum (Hedw.) Lindb.
Timmia megapolitana Hedw.
Tomenthypnum nitens (Hedw.) Loeske
Tortula ruralis (Hedw.) Gaertn, Meyer and Scherb.

Our annotated list of bryophytes collected from Bird's Hill Provincial Park is available, at a nominal charge from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. Voucher specimens have been deposited in the authors' own herbarium and at the University of Winnipeg.

Common Bryophyte Species

Sites 1–4 — open ditches, and clay banks of shallow, slow-running streams, bordered by *Carex* spp. and *Typha latifolia.*

Here *Dicranella varia* and *Riccardia pinguis* were common on wet silt and clay banks. *Riccardia pinguis* is described by Schuster (1957) as a common species of moist calcareous areas. Its abundance in Bird's Hill Park is probably a reflection of the predominantly calcareous nature of the bedrock in the park (Ehrlich et al. 1953). *Pohlia wahlenbergii, Philonotis fontana,* and *Marchantia polymorpha* were also fairly common along ditches, while on the drier banks *Dicranella schreberiana* and *Barbula unguiculata* were frequent.

In the ditches and in moist habitats along the streams, as in most other wet or moist sites in the park, *Drepanocladus* spp. and *Leptodictyum* spp. were frequent and often abundant. *Drepanocladus aduncus* var. *polycarpus* was by far the most common member of the genus, although *D. aduncus* (*typicus*), *D. revolvens,*

and *D. sendtneri* were locally abundant. *Leptodictyum trichopodium* var. *kochii* was also common, *L. trichopodium, L. brevipes* and *L. riparium* less so. Several other pleurocarps, especially *Brachythecium rutabulum, Campylium stellatum,* and *Amblystegium juratzkanum* were often found growing among *Drepanocladus* spp.

On the more exposed, drier clay banks, small acrocarps were prominent, notably *Barbula convoluta, B. fallax, Bryum creberrimum,* and *Bryum stenotrichum.* A number of species of wide ecological amplitude, e.g. *Ceratodon purpureus, Leptobryum pyriforme,* were prominent on dry banks but could also be found at most of the other sites visited.

Sites 5–9 — *Carex* marshes with hummocks and small open pools, often with *Typha,* and a shrub layer of *Salix* spp., *Cornus stolonifera,* and *Ledum groenlandicum* (7).

In these sites, *Drepanocladus aduncus* var. *polycarpus* and *Campylium stellatum* were abundant, while *Hypnum lindbergii* and *Plagiomnium rugicum* were also fairly common. Typical wetland species such as *Sphagnum capillaceum* and *Tomenthypnum nitens* were sometimes abundant.

Sites 10–14 — bog forest (see Figure 2) dominated by black spruce and tamarack (10, 11, 13, 14) or white spruce and tamarack (12), often with a *Sphagnum* or *Carex* hummock–hollow topography and a tall shrub stratum of *Cornus stolonifera, Salix* spp., and *Betula occidentalis* (11).

These collecting areas had the highest bryophyte cover and the largest number of species of all the sites visited. Deadfall in advanced stages of decay was frequent, and carried a high moss cover (see Figure 3).

There was a relatively large number of hepatics, many apparently confined to rotten wood, where *Lophocolea heterophylla, L. bidentata, Chiloscyphus pallescens, C. polyanthus,* and *Cephalozia media* were most frequent. Less often were found *Blepharostoma trichophyllum, Cephaloziella rubella, Frullania eboracensis, Lophocolea minor, Jamesoniella autumnalis,* and *Porella platyphylla. Ptilidium pulcherrimum* was common on both live and fallen bark, while *Radula complanata* was found on bark of black spruce and white cedar.

In almost all of the forested sites (10–28), the following species were common: *Platygyrium repens, Pylaisiella polyantha, Ceratodon purpureus, Campylium hispidulum, C. chrysophyllum, Brachythecium salebrosum, B. rutabulum, B. campestre, Amblystegium juratzkanum, A. serpens, Plagiomnium cuspidatum,* and *P. rugicum.* They were most prominent in the drier areas (24–28) where they were largely restricted to rotten wood. In more mesic forests they occurred mainly on dry hummock tops or stumps.

In the wetter forested sites, several species formed a conspicuous part of the ground cover, e.g. *Thuidium recognitum, Climacium dendroides, Tomenthypnum nitens,* and *Helodium blandowii. Sphagnum capillaceum* and *S. squarrosum* were also common.

A number of species were found almost exclusively in black spruce-dominated forests. These included *Hylocomium splendens, Pleurozium schreberi, Hypnum pratense, Plagiothecium denticulatum, Platydictya subtile,* and *Myurella julacea.*

Orthotrichum speciosum, O. obtusifolium, and *O. pumilum* were quite common as epiphytes on the trees in wet-mesic forested areas, *O. speciosum* being particularly common in the wetter sites.

A few small acrocarps occurred characteristically on rotten wood, e.g. *Oncophorus wahlenbergii, Tetraphis pellucida,* and *Pohlia nutans,* mixed sometimes with the pleurocarp *Haplocladium microphyllum.*

Sites 15–23 — wet-mesic forest, usually dominated by white spruce and balsam poplar (*Populus balsamifera*) except in 16 and 17 where the dominants were white spruce – white cedar and white cedar – balsam poplar respectively. Most sites had evidence of logging and a considerable amount of deadfall.

The bryophyte species collected in these sites were largely the same as those common in the black spruce areas although cover was considerably less and the number of species reduced. Hepatics in particular were much

FIGURE 2. Site 13, a black spruce bog forest, with a few tamarack bordering the willow – sedge marsh in the foreground.

FIGURE 3. Forest floor of site 13, showing deadfall and a large patch of *Thuidium recognitum* (right center). Prominent understorey vascular species are *Rubus pubescens, Cornus canadensis,* and *Carex* spp.

scarcer although several collections were made of *Lopocolea* spp. and *Chiloscyphus* spp.

Thuidium recognitum and *Climacium dendroides* were still prominent in the moister sites, while *Brachythecium* spp., *Plagiomnium* spp., *Amblystegium* spp., and *Eurhynchium pulchellum* were usually conspicuous.

Sites 24–28 — upland, usually xeric, mixedwood forest dominated by white spruce, aspen, oak, and by balsam poplar (24). *Juniperus communis* was the dominant shrub in 25 and 26, while *Corylus americana, Prunus virginiana,* and *Amelanchier alnifolia* were prominent in others.

These forests had a relatively poor bryophyte flora, consisting chiefly of common pleurocarps on rotten wood.

Liverworts were very rare. However, the only collection of *Ptilidium ciliare* in the park was made at site 25 where several large patches were found.

Polytrichum juniperinum was frequent, along with small acrocarps such as *Bryum* spp.

Sites 29–35 — granite boulders (29), and dry, sandy grassland (32, 33), sometimes crossed by trails (31), spring flooded (30), or recently burnt (35); site 34 was an abandoned gravel pit with limestone and dolomite till.

In the dry grassland areas almost all of the rather sparse bryophyte cover consisted of short turf mosses such as *Bryum argenteum, B. creberrimum, B. caespiticium, Barbula convoluta, Tortula ruralis, Encalypta procera,* and *Ceratodon purpureus,* with *Funaria hygrometrica* abundant in recently burnt areas.

Spring-flooded grasslands often had a considerable cover of *Drepanocladus aduncus* var. *polycarpus.*

The only bryophytes found on rocks were *Grimmia apocarpa* and *Hedwigia ciliata.* One collection of *Grimmia alpicola* was also made on an isolated granite boulder at site 26.

One collection of *Astomum muehlenbergianum* was made at site 35. This species has been reported only once previously for Manitoba (Longton 1972) for the Carberry area in the southwestern part of the province.

New Records

Four new records were made for the province: *Cephalozia catenulata, Platydictya confervoides, P. subtile,* and *Thuidium minutulum.*

Platydictya confervoides was found once on thin humus on a granite rock at site 26. Grout (1932) gives its distribution (as *Amblystegiella confervoides*) as New England, southeastern Canada, along the Great Lakes, and in the Rocky Mountains. As no records are listed by Bird (1966) for Saskatchewan or Alberta, the Bird's Hill collection appears to be the first from the prairie provinces, and a western extension of the species' range in Canada.

Platydictya subtile was fairly common on tree bases in black spruce – tamarack forests. Grout (1932) gives its range (as *Amblystegiella subtilis*) as follows: southern Canada and northern U.S., west to Minnesota and Wisconsin, New Jersey, Pennsylvania, Ohio, and Illinois. No records are given by Bird (1966) for the prairie provinces. The present report thus represents a northwestern extension of the range.

One collection of *Thuidium minutulum* was made on humus and well-rotted wood at site 16. According to Grout (1932), this species is most common in the southern United States, although it ranges as far north as Minnesota and New Brunswick. The present record extends its northwestern range.

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Literature Cited

Bird, C. D. 1966. A catalogue of the bryophytes reported from Alberta, Saskatchewan, and Manitoba. University of Calgary, Calgary. (Processed publication).

Crum, H., W. C. Steere, and L. E. Anderson. 1965. A list of the mosses of North America. The Bryologist 68: 377–432.

Ehrlich, W. A., E. A. Poyser, L. E. Pratt, and **J. H. Ellis.** 1953. Report of reconnaissance soil survey of Winnipeg and Morris map sheet areas. Soils Report Number 5, Manitoba Department of Agriculture.

Grout, A. J. 1932. Moss flora of North America north of Mexico. Vol. 3, Part 3, Newfane, Vermont.

Grout, A. J. 1938. Moss flora of North America north of Mexico. Vol. 1, Part 3, Newfane, Vermont.

Koponen, T. 1968. Generic revision of Mniaceae Mitt. (Bryophyta). Annales Botanici Fennici 5: 117–151.

Koponen, T. 1971. A monograph of *Plagiomnium* sect. Rosulata (Mniaceae). Annales Botanici Fennici 8: 305–367.

Longton, R. E. 1972. Nineteen bryophytes new to Manitoba. The Bryologist 75: 348–350.

National Audubon Society. 1966. Survey report and educational-use plans, natural resources center, Bird's Hill Provincial Park, Winnipeg, Canada. New York. 78 pp.

Sayre, G., C. E. B. Bonner, and **W. L. Culberson.** 1964. The authorities for the epithets of mosses, hepatics, and lichens. The Bryologist 67: 113–135.

Schuster, R. M. 1953. Boreal Hepaticae. A manual of the liverworts of Minnesota and adjacent regions. The American Midland Naturalist 49(2): i–v, 257–684.

Schuster, R. M. 1957. Boreal Hepaticae. A manual of the liverworts of Minnesota and adjacent regions. II. Ecology. The American Midland Naturalist 57(1–2): 203–299.

Schuster, R. M. 1966. The Hepaticae and Anthocerotae of North America east of the Hundredth Meridian. Volume I. Columbia University Press, New York. 802 pp.

Schuster, R. M. 1969. The Hepaticae and Anthocerotae of North America east of the Hundredth Meridian. Volume II. Columbia University Press, New York. 1062 pp.

Scoggan, H. J. 1957. Flora of Manitoba. National Museum of Canada, Bulletin 140.

Stringer, P. W. and **M. H. L. Stringer.** 1973. Studies on the bryophytes of southern Manitoba. VII. Distribution of terrestrial bryophytes in a black spruce bog in Bird's Hill Provincial Park. The Bryologist 76: 252–259.

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The Western Sandpiper in Quebec and the Maritime Provinces, Canada

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Ouellet, H., R. McNeil, and J. Burton. 1973. The Western Sandpiper in Quebec and the Maritime Provinces. Canada. Canadian Field-Naturalist 87: 291-300.

Abstract. The Western Sandpiper (*Calidris mauri*) is one of the most difficult birds to identify in the fall east of Ontario. Most fall sight records are not acceptable. Only three fall records, substantiated by specimens, are considered valid to date: two from Quebec and one from Nova Scotia. It is felt that this bird does not migrate through eastern Canada in spring. In the fall, plumage differences are very small and cannot be used to distinguish it from the Semipalmated Sandpiper (*C. pusilla*). However, the ratio culmen length/bill width, the length of the culmen, and the distance from the distal corner of the nostril to the tip of the bill proved to be statistically significant in separating the two species, provided specimens are accurately sexed.

Résumé. Le Bécasseau du Nord-Ouest (*Calidris mauri*) se compte parmi les oiseaux les plus difficiles à identifier en automne à l'est de l'Ontario. Les observations visuelles d'automne ne sont pas acceptables et seulement trois mentions ont pu être homologuées jusqu'à maintenant, soit deux du Québec et une de la Nouvelle-Ecosse. Il semble, à la lumière des données recueillies jusqu'à maintenant, que cet oiseau ne se rencontre pas dans l'est du Canada au printemps. En automne, les marques du plumage ne sont pas bien définies et ne permettent pas de le distinguer du Bécasseau semi-palmé (*C. pusilla*). Cependant, les spécimens de *C. mauri*, dont le sexe a été identifié correctement, peuvent être différenciés de ceux de *C. pusilla* à l'aide de mensurations que se sont avérées statistiquement valables, comme le rapport longueur du culmen/largeur du bec, la longueur du culmen, ainsi que la distance entre la partie distale de la narine et le bout du bec.

Introduction

A number of reports of sightings of the Western Sandpiper (*Calidris mauri*) in Quebec and the Maritime Provinces have been published, especially in the last few years. In view of the difficulty of identifying this bird in the field, particularly in the fall, and of distinguishing it from the Semipalmated Sandpiper (*C. pusilla*), we felt that a review of the records, plumage differences between the two species, and a comparative analysis of mensural characters would clarify the status of this bird in Canada, east of Ontario.

The breeding range of *C. mauri* is restricted to the western and northern coasts of Alaska (A.O.U. Check-list 1957, p. 203; Gabrielson and Lincoln 1959, pp. 398–399). In migration, it is regular in Canada only on the coast of British Columbia, whereas it is irregular or accidental elsewhere in the country (A.O.U. Check-list 1957, p. 203; Godfrey 1966, p. 161). On the other hand, *C. pusilla* has a much wider breeding range in the arctic and subarctic regions of North America. Furthermore, this species nests in the northern part of eastern Canada and is a regular, often abundant spring and fall migrant in the eastern provinces.

The spring plumages of these two sandpipers are sufficiently different and thus present no problem in field identification. In autumn, however, these two birds are particularly difficult to distinguish in the field. After having examined a few hundred specimens, we found that many individuals of the Western Sandpiper may be impossible to identify on the basis of color or size characters, even though many observers have claimed that, in addition to plumage differences, bill size and shape are reliable field characters. It has been asserted that these species can be separated on the basis of differences in feeding behavior (Ashmole 1970; Recher 1966). It is our opinion that this last

method of identification is particularly subjective in areas where *C. mauri* is scarce or accidental.

Materials and Methods

Specimens of the Western Sandpiper, representing spring and fall migrants from British Columbia and Oregon, winter residents from northern Venezuela, fall migrants from Quebec (2) and Nova Scotia (1), in the collections of the National Museum of Natural Sciences and the Université de Montréal, were examined and measured. Large series of Semipalmated Sandpipers from the breeding grounds in arctic Canada, and migrants from most eastern provinces of Canada, as well as winter residents from Venezuela also were examined and measured. The measurements consist of the following: length of exposed culmen, distance from distal corner of nostril to tip of bill, bill width at narrowest part just behind nail, unflattened wing length, and tarsal length. The ratio culmen length/width of bill was used as a basis for comparison. Color comparisons following Ridgway (1912) were made between individuals of the same sex and comparable age.

Plumage Descriptions

Nuptial (Alternate) Plumage

Although these small shorebirds are similar in plumage pattern and color in spring, nonetheless they may be safely separated on that basis alone either in the field or in the laboratory in that season. Birds taken in May, June, and early July, prior to the post-nuptial (prebasic) molt, exhibit a considerable amount of individual variation in color. However, the adults of each of these two species show certain coloration trends that are fairly constant whatever may be the extent of the individual variation and as long as the postnuptial molt is not complete. In *Calidris pusilla,* we found very little sexual variation, except that females tend to be slightly darker dorsally than males, the extent of the buffy edging of the dorsal feathers being on the whole less extensive. In *C. mauri,* females appear to be somewhat paler than males and show more whitish on the dorsal regions, particularly on the crown; also the underparts are more scantily streaked than in the males.

To facilitate field and in-hand identifications, we are providing here additional descriptive information to supplement the meticulous descriptions provided earlier by Ridgway (1919) and Godfrey (1966). In general, *C. mauri* is more heavily streaked between the neck and breast and on the sides and flanks. Feathers here bear a lanceolate or triangular subterminal mark which forms long fine longitudinal stripes particularly on the flanks and sides of the breast. These markings vary in color from dark brownish gray to blackish in both species. The main difference lies in the amount and extent of these markings. In *C. pusilla,* however, they are slightly lighter in color and much less conspicuous, particularly on the sides of the breast and on the flanks, although they retain the pointed shape. The longitudinal stripes which they form on the breast, sides, and flanks are shorter and fainter. The throat area is generally much whiter and is seldom speckled with dark markings, often appearing pure white.

Dorsally, both species are very different in nuptial plumage. The back of *C. pusilla* has often a coarser scalloped or more scaly appearance than that of its congener, which gives it a darker appearance in many cases. The feathers of these areas are edged with light buffy gray, dull russet, beige or drab, and never have the rich russet coloration (varying from hazel and cinnamon to rufous, tawny, and yellowish red (Ridgway 1912)) found on the dorsal parts of *C. mauri.* The russet markings of *C. mauri* are found on the humeral, dorsal, and femoral tracts, on the wing coverts, in the auricular and neck region, on the crown, and on the nape. This color usually occupies a subterminal position on the larger feathers, particularly those of the humeral tracts and of the wing coverts. This appears to account for the fact that the russet coloration is not always easily visible in live motionless birds when the feathers are all nicely held in place. On other parts of the body, the russet color is usually located on the tip of the feathers, but its position and extent vary considerably and form a variety of patterns, although the scalloped appearance is always re-

tained. It often differs from that of *C. pusilla* in forming a much finer pattern. In *C. pusilla,* the dorsal coloration often assumes an overall buff or sandy color, speckled with dark areas, particularly late in the season, prior to the completion of the postnuptial (prebasic) molt. It appears also that the russet of the head region in *C. mauri* is retained much longer during the postnuptial (prebasic) molt than the buffy or grayish of *C. pusilla.* This russet may occasionally form around the crown a well defined ring which is more conspicuous in the occipital and parietal regions. These remarks apply also to the auricular coverts which retain the russet coloration much longer than any other part of the dorsal region. In both species the legs have been described as blackish, dusky, dark, or blackish olive. The iris is dark to medium brown in both species in the nuptial plumage.

Adult Non-nuptial (Basic) Plumage

Prior to completion of the molt in *C. mauri,* parts of the nuptial plumage are retained in various proportions and the deep russet feathers of the dorsal region, which are often markedly faded at that time, still show through the new feathers. In the above species these, in addition to mensural data, could constitute a reliable identification character. In *C. pusilla* deep reddish brown or russet markings are lacking, but light buffy edges on the nuptial plumage feathers often persist well into the postnuptial (prebasic) molt, which, at that stage, give the bird a slightly paler appearance on the dorsum. These markings, which result from fading and abrasion, are much paler than any dorsal markings of *C. mauri.* In both species, dusky streaks are found in various proportions and positions on the underparts (breast, sides, and flanks) until the postnuptial molt is complete. These markings are heavier and appear to persist longer in *C. mauri.*

When the postnuptial (prebasic) molt has been completed, the plumage of the two species is very similar, almost identical. The underparts are pure white in both species, whereas the dorsal region varies from brownish gray and grayish brown to hair brown (Ridgway 1912). In *C. pusilla* shafts of the dorsal feathers vary from dusky to blackish, and their size and shape are also highly variable and cannot be correlated with sex or species. On the average, however, the dorsal coloration of *C. mauri* appears to be slightly darker than that of *C. pusilla.* Nonetheless, birds in full non-nuptial plumage cannot be identified on the basis of plumage coloration alone. However, it is highly improbable that birds having undergone a complete postnuptial molt could still be found in eastern Canada, as it appears that the full nonbreeding (basic) plumage is acquired much later in the fall, almost at the time when the birds reach their wintering grounds. The iris and leg colors of both species in autumn are similar to those of the respective adults in spring.

First Non-nuptial (Basic I) Plumage

During fall migration, immatures of these two species resemble closely in plumage pattern and color the adults of their own species except that the dorsal region has a more scalloped appearance which is due to the wider pale buffy edging of the feathers. Ventrally, a faint buffy band is visible across the upper part of the breast. Immatures of *C. mauri* can easily be separated from immatures of *C. pusilla* as long as the deep russet of certain feathers persists in the dorsal plumage. Otherwise, we found no difference in the dorsal coloration of these two species and conclude that they are indistinguishable on the basis of plumage alone, except when deep russet markings persist on *C. mauri.*

Mensural Characters

Apart from plumage characters, the mensural characters of the bill (culmen length and distance from the distal corner of the nostril to the tip of the bill) present a significant statistical difference (at 0.05 level) between the species and therefore could be used as identification criteria (Table 1). The difference stands out more clearly in females than in males. However, most males of the Western Sandpiper can be safely distinguished from those of the Semipalmated Sandpiper by bill measurements. The specimens whose culmen lengths exceed 23.6 and 23.3 mm for adult and immature females respectively, and 21.2

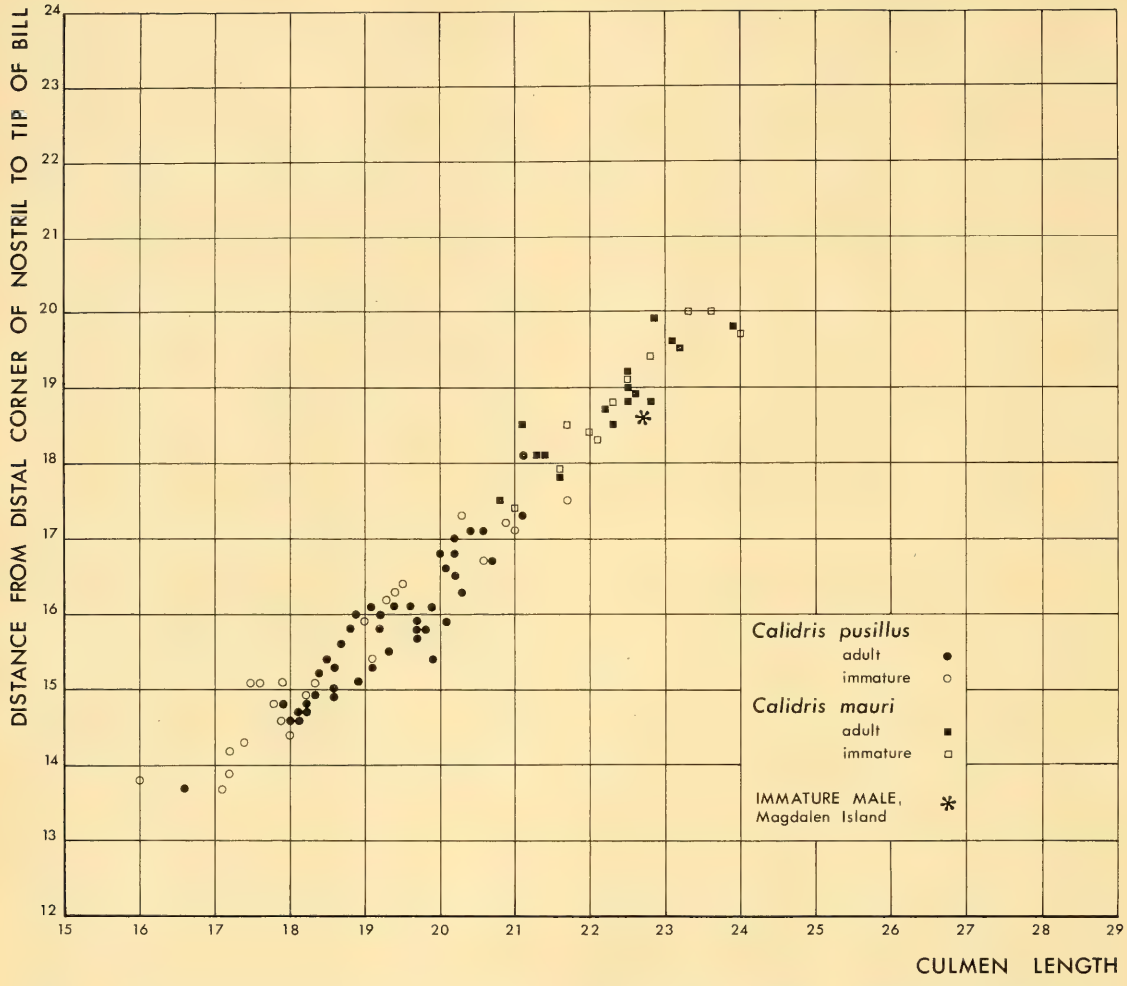

FIGURE 1. Separation of adult and immature males *Calidris pusilla* and *C. mauri* on basis of exposed culmen length and distance from distal corner of nostril to tip of bill.

and 21.7 mm for adult and immature males respectively (Table 1) are statistically referable to the Western Sandpiper. The same applies to the birds where the distance from the distal corner of the nostril to the tip of the bill exceeds 19.6 and 19.8 mm for adult and immature females respectively, and 17.5 and 17.8 mm for adult and immature males respectively. The latter character shows less overlap between the males of both species. When both the culmen length and the distance from the distal corner of the nostril to the tip of the bill are used simultaneously (Figures 1 and 2), there is almost no overlap between males (or females) of the two species. The confidence limits for individual values of culmen length given in Table 1 are in fact more conservative than Ridgway's (1919) measurements, which have been used by various other authors. Brodkorb (1967) states that *C. pusilla* has a culmen length about equal to or shorter than middle toe with claw, whereas *C. mauri* has a culmen length greater than middle toe with claw. As far as we can determine, these criteria cannot be

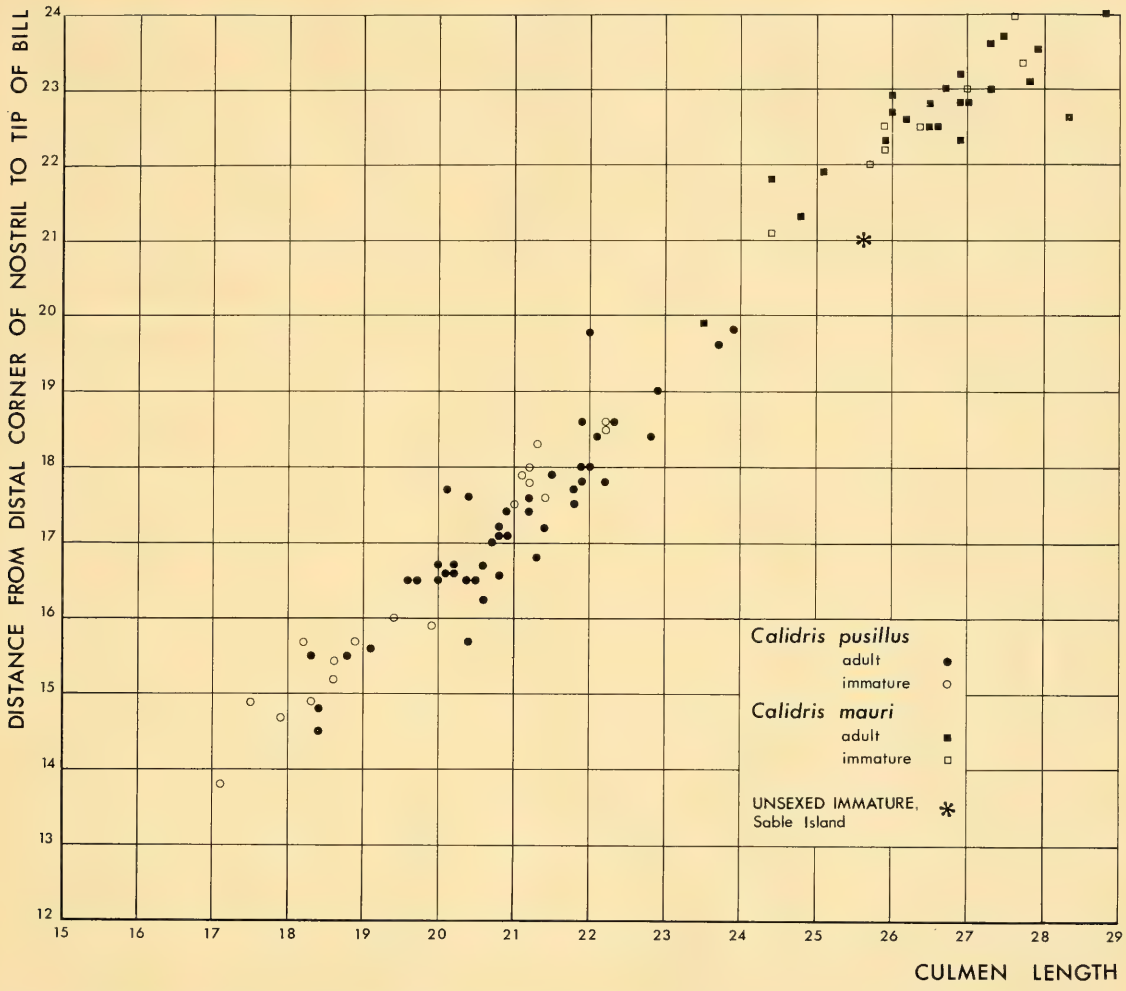

FIGURE 2. Separation of adult and immature females *Calidris pusilla* and *C. mauri* on basis of exposed culmen length and distance from distal corner of nostril to tip of bill.

used to separate both species adequately, because many Semipalmated Sandpipers have a relatively long bill, which is longer than the middle toe with claw.

Table 1 shows a broad overlap in the bill measurements of male Western Sandpipers and of female Semipalmated Sandpipers. Therefore it is clear that field identification of both species cannot safely be made, especially in mixed flocks of fall migrants or wintering birds.

The culmen length/bill width ratio (Table 1) as an additional criterion can safely be used to separate most specimens of both species, in spite of the fact that its values show greater overlapping between both species than the two previous bill characters. Specimens of which the culmen length/bill width ratio exceeds 17.8 and 17.4 for adult and immature females respectively, and 16.2 and 16.0 for adult and immature males respectively (Table 1) can be considered as *C. mauri*.

Confidence limits in bill measurements may be used in determining puzzling individuals. For example, two problematic specimens were collected respectively on Sable Island on 9 September 1970 (unsexed immature; culmen length/

TABLE 1. — Mensural characters of the Semipalmated Sandpiper and the Western Sandpiper. Measurements are in millimeters

	Semipalmated Sandpiper					Western Sandpiper				
	N	Range	Mean	Confidence limits for the mean	Confidence limits for individual values	N	Range	Mean	Confidence limits for the mean	Confidence limits for individual values
Culmen										
♂♂ adult	48	16.60–21.10	19.23	18.96–19.51	17.31–21.15	17	20.80–26.20	22.52	21.88–23.17	19.54–25.50
♂♂ immature	30	15.10–22.00	18.55	17.97–19.13	15.39–21.71	11	21.00–24.00	22.45	21.83–23.06	20.33–24.56
♀♀ adult	46	18.30–23.90	20.96	20.58–21.34	18.36–23.55	25	23.40–28.80	26.54	26.03–27.04	23.97–29.10
♀♀ immature	19	17.10–22.20	19.75	18.96–20.54	16.21–23.29	8	24.40–27.70	26.31	25.39–27.23	23.54–29.08
Distal corner of nostril to tip of bill										
♂♂ adult	46	13.70–18.10	15.73	15.47–15.99	13.97–17.49	17	17.50–22.90	19.02	18.41–19.64	16.41–21.63
♂♂ immature	30	12.70–17.50	15.34	14.89–15.78	12.90–17.72	11	17.40–20.00	18.86	18.29–19.44	16.87–20.86
♀♀ adult	46	14.50–19.80	17.24	16.88–17.59	14.84–19.63	23	19.90–24.10	22.63	22.25–23.02	20.75–24.51
♀♀ immature	18	13.80–18.60	16.47	15.70–17.23	13.13–19.80	8	21.10–24.40	22.59	21.84–23.33	20.36–24.82
Wing										
♂♂ adult	48	90.20–99.00	94.60	94.01–95.18	90.57–98.63	18	90.70–95.30	93.52	92.75–94.28	90.19–96.84
♂♂ immature	30	88.20–97.40	92.81	91.98–93.65	88.25–97.38	11	91.00–97.00	93.47	92.17–94.78	88.93–98.01
♀♀ adult	46	94.30–99.60	96.99	96.51–97.47	93.72–100.27	25	91.30–99.50	96.11	95.26–96.95	91.80–100.41
♀♀ immature	19	90.30–96.80	94.04	93.02–95.05	89.49–98.58	7	94.80–98.20	96.99	95.96–98.01	94.09–99.88
Tarsus										
♂♂ adult	48	19.50–23.40	21.15	20.92–21.37	19.56–22.73	18	21.40–23.10	22.13	21.87–22.38	21.02–23.24
♂♂ immature	30	20.00–22.70	21.28	21.03–21.53	19.90–22.66	11	20.70–22.90	21.65	21.20–22.10	20.09–23.22
♀♀ adult	45	20.50–23.70	22.04	21.83–22.26	20.59–23.49	25	22.40–25.00	23.58	23.29–23.86	22.13–25.03
♀♀ immature	18	20.40–23.10	21.80	21.44–22.16	20.22–23.38	8	22.40–24.00	23.21	22.78–24.08	21.91–24.51
Culmen length/ bill width ratio										
♂♂ adult	46	8.83–15.44	12.39	11.84–12.94	8.62–16.15	16	14.55–18.38	16.48	15.78–17.18	13.60–19.36
♂♂ immature	30	9.74–13.78	11.68	10.89–12.47	7.28–16.01	11	16.67–18.46	17.39	16.70–18.07	15.01–19.76
♀♀ adult	44	8.98–16.36	12.84	12.11–13.57	7.93–17.76	25	15.60–21.20	19.00	18.28–19.73	15.30–22.71
♀♀ immature	18	10.23–15.86	12.61	11.52–13.70	7.86–17.36	8	17.72–22.08	19.81	18.05–21.57	14.53–25.09

nostril to tip : 25.6/21.0 mm, and culmen length/bill width ratio: 18.34) and on the Magdalen Islands on 15 September 1970 (immature male; 22.7/18.6 mm, and 16.21). Because of their plumages, when compared with Semipalmated and Western Sandpipers, they are not clearly referable to any one of the two species. According to the present confidence limits for individual values of culmen length, distance from the distal corner of the nostril to the tip of the bill, and culmen length/bill width ratio (Table 1), both of them are clearly referable to *C. mauri*. If the culmen length and the distance from the distal corner of the nostril to the tip of the bill of these two specimens appear on a scatter diagram (Figures 1 and 2), it appears clearly that these two birds belong to *C. mauri,* the former specimen being probably an immature female.

There is a considerable average difference in bill length between the sexes of both species, especially in adult birds (Table 1). The mean culmen length is significantly longer ($P < 0.05$) in adult females than in adult males. This has been observed by Manning et al. (1956) in Semipalmated Sandpipers, and in several other species of shorebirds, as mentioned in pertinent literature. Page and Fearis (1971) recently published data (mean + 2 Standard Errors) enabling bird banders to sex Western Sandpipers by culmen length. Their measurements closely overlap confidence limits for the mean given in Table 1. On the other hand, wing and tarsal measurements greatly overlap in both species (Table 1), and these characters cannot serve adequately as identification criteria.

The measurements given in Table 1 for culmen length of Semiplamated Sandpipers correspond very well with those of Manning et al. (1956) for specimens collected in eastern Canada, and with those given by Godfrey (1966). However, Manning et al. (1956) found a significant difference in average bill length between Alaskan-western Canadian and eastern Canadian Semipalmated Sandpipers, the latter having longer bills. Our sample of bill lengths in adult birds from the Canadian eastern Arctic and from provinces east of Ontario (Table 1), as compared with the sample of Manning et al. (1956) for western Canada, indicates that the breeding and migrant populations of Semiplamated Sandpipers of eastern Canada have a bill which averages significantly longer ($P < 0.05$) than the bill of those of western Canada. A similar situation was observed by McNeil and Burton while banding fall migrants on the Magdalen and Sable islands in 1970. These observations are in agreement with the thinking of Manning et al. (1956) that there must be at least two fairly distinct and constant populations of Semipalmated Sandpipers: one in eastern Canada (longer bills), and one in Alaska and western Canadian Arctic (shorter bills).

Manning et al. (1956) however mentioned one complication: "Eleven American Museum of Natural History specimens, taken at Tadoussac, Quebec, between July 26 and August 14, 1889, have a mean culmen/bill width ratio of 9.75 (9.3 – 10.2) and are therefore clearly referable to the western race." These Tadoussac specimens were probably western birds that flew to the southeast during fall migration. This interpretation agrees with the concept that is gaining increasing support, that many shorebirds breeding in the western Arctic fly in a southeastward direction during fall migration and thus may be observed as far east as the Atlantic coast.

Table 2 shows the measurements of adult Semipalmated Sandpipers having a culmen length/bill width ratio smaller than 10.3 and/or a culmen length smaller than 18.1 and 19.5 mm for males and females respectively. When compared with the measurements reported by Manning et al. (1956), all these birds are referable to western birds. Eight of them are fall migrants collected in Kamouraska, Quebec. The only aberrant specimen is one adult male taken on West Foxe Island in the Hudson Strait, on 10 June 1956. This specimen (National Museums of Canada No. 41225), in culmen length (16.6 mm) resembles those of the western population. However, its culmen length/bill width ratio (10.38) is in the zone of overlap in the values of both species.

These observations agree with McNeil (1969, 1970) and McNeil and Cadieux (1972) in the

TABLE 2. — Measurements of adult Semipalmated Sandpipers having a culmen length/bill width ratio less than 10.3 and/or a culmen length less than 18.1 and 19.5 mm (after Manning et al. 1956) for males and females respectively

Museum number[1]	Sex	Locality	Date	Culmen (mm)	Culmen length/ bill width
U.M. 00869	♀	Kamouraska, Qué.	9 August 1968	19.1	10.05
U.M. 00851	♀	,, ,,	12 August 1968	18.8	9.64
U.M. 00882	♀	,, ,,	5 August 1968	20.2	9.39
U.M. 00839	♀	,, ,,	2 August 1968	18.3	10.77
U.M. 00852	♂	,, ,,	9 August 1968	18.0	9.73
U.M. 00847	♂	,, ,,	9 August 1968	18.2	9.10
U.M. 00854	♂	,, ,,	9 August 1968	18.1	8.83
U.M. 00895	♂	,, ,,	2 August 1968	17.9	10.53
N.M.C. 41225	♂	West Foxe Island, N.W.T.	10 June 1956	16.6	10.38

[1]U.M.: Université de Montréal; N.M.C.: National Museums of Canada.

belief that the Semipalmated Sandpiper uses a fall migration route which follows an eastward course, and that some individuals must use an oversea route from the Maritime Provinces and New England States to the Lesser Antilles and northeastern South America. Furthermore, it should be pointed out that many adult fall migrants of *C. pusilla* taken in the first half of August on the Magdalen Islands proved to have significantly higher amounts of premigratory fat than did spring migrants before their departure from northern Venezuela (McNeil and Cadieux 1972). Ten individuals were found to have a flight-range capability exceeding 2,000 miles.

Other Means of Field Identification

Neither the aggressive behavior (Recher 1966, p. 397) nor the mode of feeding (Ashmole 1970, pp. 131–135) of *C. mauri* in the presence of *C. pusilla* appear to us to be reliable field characters in the fall. One of us (McNeil) has had considerable experience with both species on the wintering grounds in northern Venezuela where no behavioral differences in the two were observed. In addition, it was found impossible to identify in the field a high proportion of the birds in mixed flocks. However, individuals of *C. mauri,* which had retained russet feathers in the dorsal region and/or had a decidedly longer bill, could be picked out in the mixed flocks, whereas the identity of many other individuals could not be determined in the field and proved very difficult to ascertain in the hand. The call note of *C. mauri* seems somewhat different from that of *C. pusilla* (W. E. Godfrey, personal communication) and may prove, even in the fall, to be a reliable field character. The call of the former species consists of a high-pitched, almost shrill 'cheep,' sometimes repeated (W. E. Godfrey, personal communication). We recommend the greatest caution in field identification on the basis of behavioral differences, at least in the case of Western Sandpipers suspected of occurring in eastern Canada.

Status

The Western Sandpiper has been reported on several occasions in Quebec and the Maritime Provinces during spring and fall migration. Well substantiated spring observations would, in our estimation, be acceptable owing to the fact that the bird can be readily distinguished in the field from *C. pusilla* in that season, but *C. mauri* is not known to migrate through eastern Canada in spring. On the other hand, most fall records must be treated as hypothetical and only those substantiated by specimens are acceptable.

Records in Quebec

Western Sandpipers were recorded in these locations in the spring: Pointe-au-Père, 14 June 1934 (Anonymous 1934); Rivière-Moisie, 26 June 1957 (Anonymous 1957); Kamouraska, 8 June 1950 (Anonymous 1951). To date, we consider the observations recorded in Quebec during the spring migration as highly improbable and refer to them all as hypothetical because no satisfactory evidence of their occurrence nor specimens were provided.

There are two definite fall records for Quebec: Dune de l'Est, on the Magdalen Islands, an immature male, collected on 15 September 1970 by R. McNeil (Collection ornithologique, Université de Montréal, No. 02571); Lachine, on Montreal Island, an adult female, collected by T. W. Thormin on 9 September 1970 (National Museums of Canada, No. 57449). In addition, in autumn *C. mauri* has been reported several times in Quebec. However, lacking satisfactory evidence we regard the following observations as hypothetical: Laprairie, near Montreal (Anonymous 1958); Lachine, also near Montreal (Anonymous 1964, 1965); Ile du Moine, near Sorel (Anonymous 1964). This bird may also occur elsewhere in Quebec, but to date no evidence of its presence is available.

Records in the Maritime Provinces

A number of reports of *C. mauri* in the Maritime Provinces have been published, but the majority of them are not satisfactorily documented, especially those pertaining to the fall migration. An unsexed immature, collected on Sable Island, Nova Scotia, by Jean Burton, on 9 September 1970 (Collection ornithologique, Université de Montréal, No. 02690) constitutes the only acceptable fall record of the species in the Maritimes. On the other hand, a few spring and late summer records, mostly unpublished, appear acceptable but we must consider them as hypothetical also until indisputable data have been obtained. The only published spring record is of one observation from Mary's Point, near Harvey, Albert County, New Brunswick, on 13 June 1971 (Finch 1971, p. 706). Except for the specimen collected on Sable Island, we know of no acceptable record for the Maritimes.

Conclusions

We believe that the Western Sandpiper in autumn is probably the most difficult shorebird to identify in the field in Canada, east of Ontario. Specimens in the hand often cause some problems but the culmen length/bill width ratio, in addition to the length of the culmen, and the distance between the distal corner of the nostril to the tip of the bill are useful aids to identification, provided specimens are accurately sexed. There is no proof to date that this bird migrates through eastern Canada in spring. At present, we accept only the fall records that are based on specimens. Sight records reported in the literature we regard as hypothetical.

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Literature Cited

Anonymous. 1934. Annual report of the Provancher Society of Natural History of Canada for 1934. p. 22.

Anonymous. 1951. Annual report of the Province of Quebec Society for the Protection of Birds for 1950. p. 28.

Anonymous. 1957. Bulletin ornithologique 2(3): 6.

Anonymous. 1958. Annual report of the Province of Quebec Society for the Protection of Birds for 1958. p. 27.

Anonymous. 1964. Annual report of the Province of Quebec Society for the Protection of Birds for 1964. p. 23.

Anonymous. 1965. Annual report of the Province of Quebec Society for the Protection of Birds for 1965. p. 26.

American Ornithologists' Union. 1957. Check-list of North American birds. 5th edition. American Ornithologists' Union, Baltimore.

American Ornithologists Union. 1973. Thirty-second supplement to the American Ornithologists' Union check-list of North American birds. The Auk 90(2): 411–419.

Ashmole, M. J. 1970. Feeding of Western and Semipalmated Sandpipers in Peruvian winter quarters. The Auk 87: 131–135.

Brodkorb, P. 1967. Birds. *In* Vertebrates of the United States. W. F. Blair, H. P. Blair, P. Brodkorb, F. R. Cagle, and G. A. Moore. Second edition. McGraw-Hill Book Co., New York.

Finch, D. W. 1971. Regional reports: Northeastern Maritime Region. American Birds 25(4): 705–710.

Gabrielson, I. N. and **F. C. Lincoln.** 1959. The birds of Alaska. The Stackpole Company, Wildlife Management Institute, Harrisburg, Pennsylvania, and Washington, D.C.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada, Bulletin No. 203.

Manning, T. H., E. O. Höhn, and **A. H. Macpherson.** 1956. The birds of Banks Island. National Museum of Canada, Bulletin No. 143.

McNeil, R. 1969. La détermination du contenu lipidique et la capacité de vol chez quelques espèces d'oiseaux de rivage (Charadriidae et Scolopacidae). Canadian Journal of Zoology 47: 525–536.

McNeil, R. 1970. Hivernage et estivage d'oiseaux aquatiques nord-américains dans le Nord-Est du Venezuela (mue, accumulation de graisse, capacité de vol et routes de migrations). L'Oiseau et la Revue Française d'Ornithologie 40: 185–302.

McNeil, R. and **F. Cadieux.** 1972. Fat content and flight range capabilities of some adult spring and fall migrant North American shorebirds in relation to migration routes on the Atlantic coast. Le Naturaliste Canadien 99: 589–605.

Page, G. and **B. Fearis.** 1971. Sexing Western Sandpipers by bill length. Bird-banding 42: 297–298.

Recher, H. F. 1966. Some aspects of the ecology of migrant shorebirds. Ecology 47: 393–407.

Ridgway, R. 1912. Color standards and color nomenclature. Published by the author, Washington, D.C.

Ridgway, R. 1919. The birds of North and Middle America. United States National Museum, Bulletin 50, part 8.

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Notes

Fishing Behavior of a Wolf on the Taltson River, Northwest Territories

Abstract. During June and July 1972 a female wolf was observed capturing whitefish moving through a rapids in the Taltson River, Northwest Territories. Fishing consisted of either approach–withdraw or approach–follow–capture–retrieve sequences. The wolf captured 16 whitefish in one 60-minute period, but the capture rate exceeded five fish during one 15-minute period. The female succeeded in capturing a fish in about half of her attempts. An adult male and two yearling wolves were also observed, but they did not participate in fishing. The yearlings occasionally watched the activities of the female. Fish may be an important seasonal food for some wolves in the Taltson River Area.

During summer 1972, I conducted research on muskrat habitat in the Taltson River region (61°05′ N, 112°35′ W) southeast of Great Slave Lake, Northwest Territories. This area, situated in the Mackenzie Lowlands near the edge of the Precambrian Shield, is characterized by typical boreal forest vegetation. The terrain is relatively flat with occasional granitic outcroppings.

On 28 June I was canoeing downstream on the Taltson River, accompanied by W. Salo, when we observed a black wolf (*Canis lupus*) moving beside an upcoming rapids. I watched the wolf with 7×35 binoculars from 1400 hours until 2100 hours, while we established a camp opposite the rapids. During this period it became apparent that the wolf, a large female, was capturing whitefish (*Coregonus* sp.).

Investigation of the rapids revealed that whitefish were abundant and were swimming upstream to spawn. Although most whitefish normally spawn in fall, I observed increasing numbers of whitefish at these rapids on 31 May and 2 June. This unusual spring spawning run of whitefish is apparently a regular event on the Taltson River, according to information obtained from J. Beaulieu, Game Patrolman at Fort Resolution, N.W.T. The spawning run appeared to have reached its peak on or about 28–30 June.

The wolf was intermittently observed from 28 June to 1 July. Continuous observations of the wolf were made from 1330 to 1500 hours on 29 June. The wolf's activities were studied from a distance of 30 to 80 yards, while I was concealed on an island in the middle of the river. A series of photographs were taken using a 200-mm telephoto lens. We left the area about 1200 hours on 1 July.

Fishing began with the female standing or sitting approximately 3–4 feet from the water (Figure 1a). Her shadow did not extend onto the water surface. She watched the movement of fish as they swam upstream and moved her head in the direction of travel. When fish came within 4 or 5 feet of the bank, she would rise and approach. If prey moved beyond this distance, she would withdraw into her watching posture. The approach and withdraw movements appeared as one motion. However, if the prey remained after her initial approach, the wolf would lunge into the rapids (Figure 1b). One or both hindlegs always remained on the bank, while her head and forelegs pivoted from the bank to follow the fish in the water. When a fish was captured in her jaws, the wolf would retrieve the fish by forcefully pivoting toward the bank (Figure 1c). If the fish had been dropped during this motion, the momentum would probably have been sufficient to cast it out of the water onto the bank. When the prey appeared to be insecurely held, she would drop and catch the live fish in the air to gain a firmer hold before proceeding into the brush. Generally, she returned without the fish within 45 seconds and continued fishing.

During one hour of intensive observation, 16 whitefish were caught by the wolf. Five fish were caught in one 15-minute period. Her capture success averaged 50 per cent, an attempt being defined as any lunge into the water to catch fish.

During the intensive observations, occasional sightings were made of three other wolves in the vicinity of the rapids. Two of these, one black and one brownish gray, were noticeably smaller than the black female and were believed to be yearlings. The other wolf was a large silver-gray adult male.

Alternately, the yearlings would take turns crouching for 3- to 4-minute periods behind small bushes about 50 feet behind and 15 feet above the female as though to observe the fishing sequence. This pattern was repeated at least four times. Occasionally, the female would look back toward the onlooker, at which time the yearling would turn and trot into the brush. Some form of

FIGURE 1. Sequence of a female wolf capturing whitefish on the Talston River, N.W.T.
(a) Wolf watching fish swimming through rapids,
(b) lunge of wolf into water in pursuit of fish,
(c) retrieval of fish following capture.

auditory communication may have occurred; however, no sounds were heard because of the roar of the rapids. The adult male did not participate in the fishing activities.

Upon my return to the rapids with G. Avery via motor canoe on 29 July, a large black wolf, presumably the same female as previously observed, was momentarily sighted at the rapids in the original fishing location. However, the wolf retreated into the bush upon sighting the canoe approaching upstream. No fish were observed in the rapids. All four wolves were observed briefly on 31 July at a rapids 2 miles downstream from the original location.

I believe this sequence of observations represents the first documented observation of fishing behavior by the wolf. Kuyt (1972, p. 21) states "I have not been able to determine how wolves obtain fish, and whether fish are caught alive or found dead." He further commented that "fish are important in the diet of wolves, where caribou are absent during most of the denning season." This statement characterizes the situation in the Taltson River area where I made my observations. Mech (1970, p. 178) did not give particular attention to fish as a prey species of wolves but listed it with eight other small animal food items which "are often found in wolf droppings."

Both Mech (1970) and Kuyt (1972) made brief reference to Young and Goldman (1944, p. 251) who stated "During September 1941, W. H. Jackson observed wolves feeding on salmon near Anchor Pass in the Ketchikan area of southeastern Alaska." Here he found "they had taken at least 90% of the salmon from the creek, eating only the heads. Many fish were not touched at all. Their tactics in catching a salmon, as described by Jackson, vary little from those employed by the Alaskan bears." Unfortunately, the fishing behavior was not described by Young and Goldman (1944) and the article by Jackson (1942) was not available for review.

Only Kuyt (1972) found fish to be important in the diet of wolves. Mech (1970) considered fish to be an unimportant food item, and Pimlott *et al.* (1969) did not mention fish as food in their study. From my observations, I believe that fish may be an important seasonal food item in the summer diet of some wolves in the Taltson River region.

Acknowledgments

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Literature Cited

Jackson, W. H. 1942. Three unlucky wolves. Alaska Sportsman 8: 8–9.

Kuyt, E. 1972. Food habits of wolves on barrenground caribou range. Canadian Wildlife Service Report Series, Number 21: 1–36.

Mech, L. D. 1970. The wolf. Natural History Press, Garden City, New York. 384 pp.

Pimlott, D. H., J. A. Shannon, and **G. B. Kolenosky.** 1969. The ecology of the timber wolf in Algonquin Provincial Park. Ontario Department of Lands and Forests Research Reports (Wildlife) Number 87: 1–92.

Young, S. P. and **E. A. Goldman.** 1944. The wolves of North America. American Wildlife Institute, Washington, D.C. 385 pp.

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New Data on the Distribution of the Moss *Splachnum rubrum* in Alberta

In the summer of 1968, during studies of the forest types near Drayton Valley, Alberta, I found a small colony of *Splachnum rubrum* Hedw. *Splachnum rubrum* is a circumboreal moss species, occurring only in the Northern Hemisphere (Schofield, 1969). The species is widely distributed in the boreal forests of North America, but very rarely found or reported.

The colony was about 10 cm in diameter and roughly circular in shape (see Figure 1). Apparently it was established on a small heap of semi-decomposed animal droppings, the usual substratum for the species. The height of the plants was about 15 cm, including a green gametophyte 3 cm long and a sporophyte 12 cm long. The seta were soft, red, mostly erect, bearing a capsule with a dark reddish-purple, umbrella-shaped hypophysis.

FIGURE 2. Locations and dates of reported collections of *Splachnum rubrum* in Alberta.

The specimen was found at 53°21′ North and 115°20′ West in a white spruce – black spruce forest on boggy soil (Peaty Low Humic Eluviated Gleysol), at approximately 3000 feet above sea level.

Other mosses found in the vicinity included *Sphagnum fuscum* (Schimp.) Klinggr., *Pleurozium schreberi* (Brid.) Mitt., *Hylocomium splendens* (Hedw.) B.S.G., *Ptilium crista-castrensis* (Hedw.) De Not., *Climacium dendroides* (Hedw.) Web. & Mohr., and *Dicranum fuscescens* Turn.

In Alberta, the species had been reported previously about 140 years ago (Drummond, 1830; Bird, 1962) from Jasper National Park near Jasper House. The present finding may be a new distribution record of this moss in west central Alberta. The identification of the moss was confirmed by Dr. C. D. Bird, University of Calgary.

Duplicates of the collection are located now in the herbaria of the University of Calgary, Calgary, Alberta and at the Northern Forest Research Centre, Canadian Forestry Service in Edmonton, Alberta.

In 1970, another specimen was found by Ian Corns, 25 miles northwest of Edson, Alberta in a pine forest at 3600 feet elevation. This specimen is located in the herbarium of the University of Alberta, Edmonton, Alberta.

Figure 2 shows the three locations of the reported collections.

GYÖRGY LÁSZLÓ LESKÓ

Literature Cited

Bird, C. D. 1962. A catalogue of the Bryophytes reported from Alberta, Saskatchewan, and Manitoba. University of Alberta, Edmonton, Alberta. 30 pp.

Drummond, T. 1830. Sketch of a journey to the Rocky Mountains and to the Columbia River in North America. Hooker's Botanical Miscellany 1: 178–219.

Schofield, W. B. 1969. Some common mosses of British Columbia. British Columbia Provincial Museum, Handbook No. 28. Victoria. 262 pp.

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FIGURE 1. A small colony of *Splachnum rubrum* Hedw. found near Drayton Valley, Alberta.

Comparison of Food Habits and Mercury Residues of Caspian and Common Terns

The food habits of Common Terns, *Sterna hirundo,* and Caspian Terns, *Hydroprogne caspia,* nesting on Little George Island, 52°52′ N, 97°47′ W in Lake Winnipeg were investigated in 1971. Food pellets, regurgitated by the terns were collected through June and July. Caspian Terns fed mostly on fish while insects dominated in the diet of Common Terns (Table 1). From the size of the fish bones in the food pellets, it could also be determined that Caspian Terns generally fed on larger fish than did Common Terns.

TABLE 1. — Percentage frequency of food items in 784 Caspian and 316 Common Tern pellets collected June–July, 1971.

Food items	% pellets with food items	
	Caspian Terns	Common Terns
Fish	100.0	35.4
Insects	6.0	92.4
Egg shells (terns)	3.2	0
Bird bones	0.3	0

Studies by Bligh (1970) and Wobeser et al. (1970) revealed high mercury residues in fish from the Wabigoon-English River system and the Saskatchewan River, respectively. Both rivers flow into Lake Winnipeg, and high mercury residues in fish have been found in that lake (Bligh 1970). Inasmuch as Caspian and Common Terns are fish eaters and as fish in Lake Winnipeg have high mercury residues, eggs of both tern species were analyzed for mercury.

Twenty eggs were collected from each species, one egg from each nest, through the laying season of the terns, which lasted from the end of the first week of June till the end of July (Vermeer 1972). The egg contents were placed into glass jars and then frozen. The egg contents were analyzed for mercury residues by Dr. L. M. Reynolds of the Ontario Research Foundation, as described by Vermeer (1971).

The total mercury residues are given in parts per million (ppm) on a wet (fresh) weight basis.

Many pesticide residue distributions examined to date have not been normal, but skewed towards higher values (Risebrough, personal communication). Therefore the mean mercury levels in tern eggs were calculated directly from the residue data as well as from their logarithmic conversion. Inasmuch as no significant differences were observed between means calculated by those two computations (Table 2), the residue data were assumed to be normally or near-normally distributed for each species. It can be seen from Table 2 that the Caspian Terns had significantly higher residue levels than the Common Terns. The difference in mercury contamination between the two species may result from interspecific differences in food habits as well as from interspecific differences in prey size.

TABLE 2. — Means and 95% confidence intervals of mercury residues (ppm) in 20 eggs of Caspian and 20 eggs of Common Terns.

Type of computation	Caspian Tern eggs	Common Tern eggs
Direct	0.90±0.16	0.58±0.09
Logarithmic conversion	0.85±0.05	0.55±0.04

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Literature Cited

Bligh, E. G. 1970. Mercury and the contamination of fresh water fish. Fisheries Research Board of Canada, Manuscript Report Series No. 1088. 27 pp.

Vermeer, K. 1971. A survey of mercury residues in aquatic bird eggs in the Canadian Prairie Provinces. Transactions of the Thirty-sixth North American Wildlife and Natural Resources Conference 36: 138–152.

Vermeer, K. 1972. Comparison of the clutch initiation of Caspian and Common Terns at Lake Winnipeg. Blue Jay 30: 218–220.

Wobeser, G., N. O. Nielsen, R. H. Dunlop, and **F. M. Atton.** 1970. Mercury concentrations in tissues of fish from the Saskatchewan River. Journal of the Fisheries Research Board of Canada 27: 830–834.

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Comparison of Egg-laying Chronology of Herring and Ring-billed Gulls at Kawinaw Lake, Manitoba

Abstract. The egg-laying chronology of inland populations of Herring Gulls and Ring-billed Gulls was studied at Kawinaw Lake, Manitoba in 1971. Clutch initiation of the Herring Gulls is less abrupt than in Ring-billed Gulls, but is in this respect similar to that of Herring Gulls breeding at the sea coast. Possible explanations for differences in laying chronology between Herring and Ring-billed Gulls are given.

Although the egg-laying chronology of coastal Herring Gulls, *Larus argentatus,* is known from studies by Barth (1967), Harris (1964), Paludan (1951), and MacRoberts and MacRoberts (1972) in Europe, and by Erwin (1971) in North America, there appears to be little information on the laying chronology of Herring Gulls in an inland environment.

The California Gull, *Larus californicus* and the Ring-billed Gull, *Larus delawarensis* in Alberta were observed to initiate egg-laying abruptly (Vermeer 1970a). To learn whether Herring Gulls exhibited a similar abrupt clutch initiation pattern as is the case with California and Ring-billed Gulls, the laying chronology of Herring Gulls was studied in May and June 1971 on two islands, each approximately one acre in size, in Kawinaw Lake (52°50′ N, 99°29′ W), in Manitoba. Comparisons were made with a colony of Ring-billed Gulls nesting on another island in the same lake.

Methods

The nests were observed from May 10 to June 20, 1971. Each nest was marked by a sturdy, wooden block, 1-foot long, bearing a numbered metal tag. Although most clutches were found during the laying period, where initiation dates were not known, clutches were back-dated from the time of hatching.

For the Herring Gulls at Kawinaw Lake in 1971 (Vermeer 1971) the calculation of back-dating was based on 33 known incubation periods and 62 egg-laying intervals, which averaged 25.8 and 2.3 days respectively. Data for Ring-billed Gulls were based on 64 known incubation periods and 58 egg-laying intervals, which averaged 25.0 and 1.9 days respectively, at Miquelon Lake, Alberta in 1964.

Results

Figure 1 compares the clutch initiation in nests of 130 Herring Gulls and 167 Ring-billed Gulls. The Herring Gulls started egg-laying 2 weeks before Ring-billed Gulls. Figure 1 also shows that Ring-billed Gulls initiated their clutches more abruptly than did the Herring Gulls.

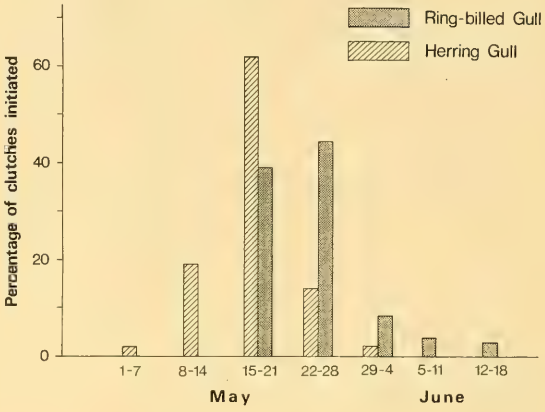

FIGURE 1. Distribution of clutch initiation of Herring Gulls and Ring-billed Gulls at Kawinaw Lake, Manitoba.

Fifty percent of the Ring-billed Gull clutches were initiated during the first week of laying, as compared to 15% of those of Herring Gulls. In Alberta, 59% of 473 Ring-billed Gull clutches were also initiated during the first week of the laying period at Miquelon Lake in 1964 and 1965.

In Figure 2 the cumulative distribution of clutch initiation of Herring and Ring-billed Gulls at Kawinaw Lake is compared with that of Herring Gulls breeding along the sea coast (Erwin 1971; Harris 1964; MacRoberts and MacRoberts 1972; Paludan 1951) and Ring-billed Gulls breeding inland at Miquelon Lake, Alberta (Vermeer 1970a). Because the nests of Ring-billed Gulls at Kawinaw Lake were checked less frequently than those of Herring Gulls, the clutch initiation of the former is shown on a weekly basis. The clutch initiation curve of Herring Gulls studied by Harris (1964) terminates abruptly because he did not record the few late season clutches. The clutch initiation of Herring Gulls studied by Paludan (1951) is shown only for 1943, because his data for 1944 are irregular owing to interference by a snowstorm. The conclusion to be drawn from the studies in

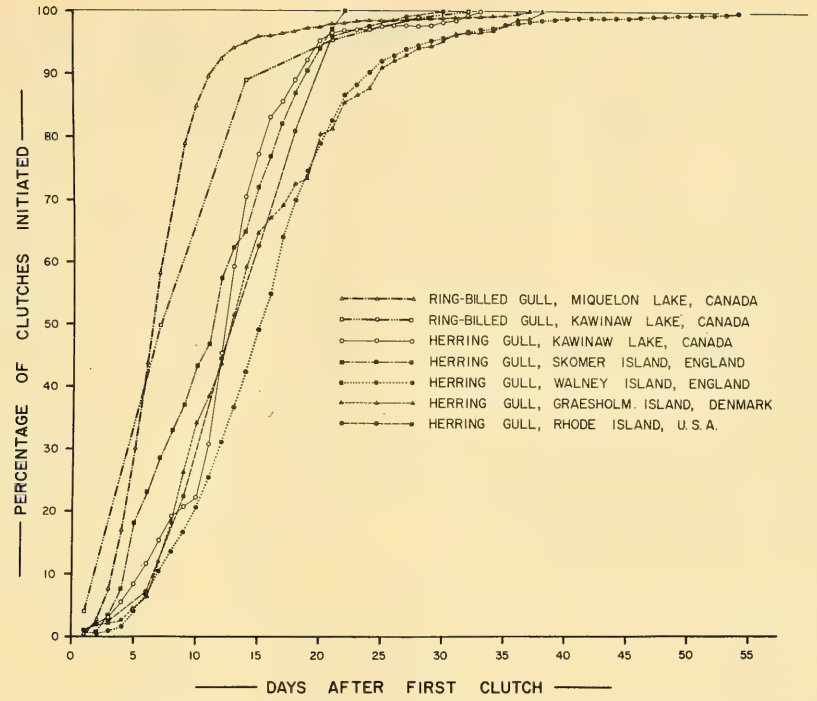
PERCENTAGE OF CLUTCHES INITIATED
DAYS AFTER FIRST CLUTCH
RING-BILLED GULL, MIQUELON LAKE, CANADA
RING-BILLED GULL, KAWINAW LAKE, CANADA
HERRING GULL, KAWINAW LAKE, CANADA
HERRING GULL, SKOMER ISLAND, ENGLAND
HERRING GULL, WALNEY ISLAND, ENGLAND
HERRING GULL, GRAESHOLM ISLAND, DENMARK
HERRING GULL, RHODE ISLAND, U.S.A.

FIGURE 2. Cumulative distribution of clutch initiation of 473 and 167 Ring-billed Gull clutches at Miquelon and Kawinaw Lakes respectively; and 130, 729, 300, 91, and 88 Herring Gull clutches at Kawinaw Lake, Canada, Walney Island (MacRoberts and MacRoberts 1972) and Skomer Island (Harris 1964), England, Graesholm Island (Paludan 1951), Denmark, and Rhode Island, U.S.A. (Erwin 1971), respectively.

Figure 2 is that the clutch initiation of Ring-billed Gulls is more abrupt than that of Herring Gulls.

Discussion

Kruuk (1964) and Patterson (1965) suggested that synchronized egg-laying in Black-headed Gulls, *Larus ridibundus,* had an anti-predator function. Patterson found that predation mainly by foxes was relatively higher for late-hatched broods than those hatched during the peak of hatching. As Kruuk and Patterson suggested for Black-headed Gulls, the synchronized clutch initiation at the start of egg-laying in Ring-billed Gulls may also be influenced by predation. Ring-billed Gulls are susceptible to avian predators such as California Gulls and Herring Gulls in western and eastern North America respectively. Ring-billed Gulls nesting on islands in shallow lakes of the prairies are susceptible to mammalian predators such as coyotes (Vermeer 1970a, 1970b). Herring Gulls are restricted to the larger and deeper lakes in the Canadian prairie provinces (Vermeer, in press) which are less accessible to mammalian predators.

The abrupt start of egg-laying in Ring-billed Gulls could be influenced by social stimulation. Ring-billed Gulls nested considerably closer to one another than Herring Gulls at Kawinaw Lake. Darling (1938) concluded that the degree of synchronized breeding by social stimulation may be density related. However, Glaucous-winged Gulls, *Larus glaucescens,* initiated egg-laying earlier but less abruptly where they nested most densely (Vermeer 1963). No convincing evidence was found for intraspecific social stimulation of reproduction in Herring Gulls and Lesser Black-backed Gulls, *Larus fuscus* (MacRoberts and MacRoberts 1972). Hence social stimulation may not account for abrupt clutch initiation in gulls.

Differences in food availability for the two species at the start of breeding may explain the later start of egg-laying of Ring-billed Gulls than Herring Gulls. Food pellets, containing mostly crayfish and insects regurgitated by the Ring-billed Gulls, were not found until the fourth week of

May and at that time they were small and scarce compared to the large and frequently encountered pellets containing fish, of Herring Gulls at Kawinaw Lake. Fish may have become earlier available to Herring Gulls than crayfish and insects to Ring-billed Gulls.

In summary, it seems that the abrupt and late clutch initiation of Ring-billed Gulls may be influenced by predation and food availability respectively.

Literature Cited

Barth, E. K. 1967. Egg dimensions and laying dates of *Larus marinus, L. argentatus, L. fuscus* and *L. canus*. Nytt Magasin for Zoologi 15: 1–34.

Darling, F. F. 1938. Bird flocks and the breeding cycle. A contribution to the study of avian sociality. Cambrdige University Press, Cambridge.

Erwin, R. M. 1971. The breeding success of two sympatric gulls, the Herring Gull and the Great Black-backed Gull. Wilson Bulletin 83: 152–159.

Harris, M. P. 1964. Aspects of the breeding biology of the gulls *Larus argentatus, L. fuscus* and *L. marinus*. Ibis 106: 432–456.

Kruuk, H. 1964. Predators and anti-predator behaviour of the Black-Headed Gull (*L. ridibundus*). Behaviour (Suppl.) 11: 1–130.

MacRoberts, B. R. and **M. H. MacRoberts.** 1972. Social stimulation of reproduction in Herring and Lesser Black-backed Gulls. Ibis 114: 495–506.

Paludan, K. 1951. Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. Videnskabelige Meddelelser fra Dansk, Naturhistorisk Forening I København 114: 1–128.

Patterson, I. J. 1965. Timing and spacing of broods in the Black-headed Gull. Ibis 107: 433–459.

Vermeer, K. 1963. The breeding ecology of the Glaucous-winged Gull (*Larus glaucescens*) on Mandarte Island, B.C. British Columbia Provincial Museum Occasional Paper 13. 104 pp.

Vermeer, K. 1970a. Breeding biology of California and Ring-billed Gulls: a study of ecological adaptation to the inland habitat. Canadian Wildlife Service Report Series 12. 52 pp.

Vermeer, K. 1970b. A study of Canada Geese, *Branta canadensis*, nesting on islands in southeastern Alberta. Canadian Journal of Zoology 48: 235–240.

Vermeer, K. 1971. Some breeding aspects of Herring Gulls at Kawinaw Lake, Manitoba. Blue Jay 29: 207–208.

Vermeer, K. In press. Food habits and breeding range of Herring Gulls in the Canadian prairie provinces. Condor.

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The Wood Turtle, *Clemmys insculpta* (LeConte): An Addition to the Herpetofauna of Cape Breton Island, Nova Scotia

The only published report of a freshwater turtle from Cape Breton Island is of a Common Snapping Turtle, *Chelydra serpentina serpentina,* taken at Port Hood and thought most likely to be an escaped captive. It is mentioned by both Bleakney (1958. A zoogeographical study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155 pp. 1–119) and Powell (1965. Zoogeography and related problems of turtles in Nova Scotia. M.Sc. Thesis, Acadia University, Wolfville, N.S. 84 pp.). Bleakney (1958) postulated that turtles never crossed to Cape Breton Island during the post-Pleistocene land connection with the mainland.

Since 1965 evidence of a natural population of the Wood Turtle, *Clemmys insculpta,* on Cape Breton Island has been gradually accumulating and now seems sufficiently conclusive to warrant published documentation. (See Figure 1).

One adult male Wood Turtle was collected in McLellan Brook, a tributary of River Inhabitants, Inverness County, Nova Scotia, on October 17, 1965, by Guy Innocent. It had a peculiar claw-like growth on its neck and was sent to Dr. Ron Sonstegard, University of Guelph, Guelph, Ontario.

One further observation of a Wood Turtle on Cape Breton Island was made in the summer of 1967 at Ingonish Beach, Victoria County, (approximately 76 miles northeast of River Inhabitants) by Ron Harper, then Park Naturalist, Cape Breton Highlands National Park. This specimen was released at Freshwater Lake, Victoria County. Wayne Neily (personal communication), present Park Naturalist, suggested that it probably was a released captive since no further reports have been made since that time.

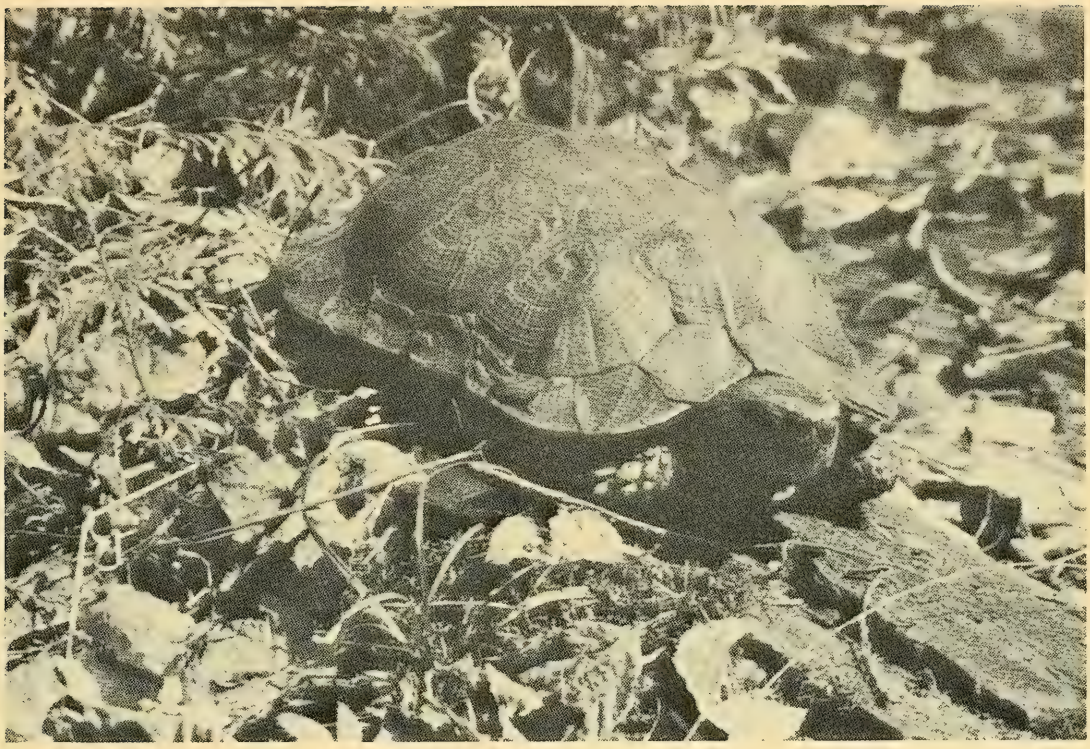

Figure 1. Wood Turtle — photograph courtesy of the National Museum of Natural Sciences Herpetology Unit.

One of us (B.G.) found a dead juvenile Wood Turtle on the Trans-Canada Highway near the bridge at McLellan Brook in May 1969, and the skeletal remains of an adult male on July 29, 1972 in a gravel pit pond near Rough Brook, also a tributary of River Inhabitants.

Three specimens, one juvenile female and two adult males, were also collected by one of us (B.G.) on July 29, 1972, near the mouth of McLellan Brook where it enters River Inhabitants. They were deposited in the National Museum of Natural Sciences, Ottawa (Catalogue Number: juvenile female, 14947; two adult males, 14948). The female was found at a place where the river was approximately 25 feet wide, but only about 8 inches deep. Here the river bottom was fine gravel. One male was found in long grass on top of a 5-foot embankment and about 20 feet from the river. The river in this area had a red clay bottom and the opposite shore was a gravel bar. The second male was dipped from the river bottom in about 3 feet of water. At this site willows and alders grew out over the water from a sloping clay bank. The slope continued under water to a depth of about 7 feet, then rose sharply to the opposite vertical bank of clay. The excrement from these three turtles indicated that they had been feeding on blueberries.

None of the Wood Turtles examined had holes drilled in the marginal scutes or any other markings frequently found on turtles held for a time in captivity.

Mrs Nellie Murrand, an elderly resident of the area, told one of us (J.G.) that Wood Turtles were common years ago at Rough Brook, and were frequently seen in the grass near her home, but she had not seen one in the last 10 years. Mr. Malcolm MacDonald, an elderly farmer of River Inhabitants, also said that Wood Turtles were seen occasionally at both Rough Brook and McLellan Brook, but were more common in River Inhabitants where it abuts his farm, and he pointed out a sandy embankment where he had accidently uncovered Wood Turtle eggs (Figure 2). In this area River Inhabitants is a slow-moving, meandering stream running through a fertile valley and is

Figure 2. Wood Turtle nesting site beside River Inhabitants.

banked mostly by alders, hayfields, and meadows. Mr. MacDonald said that although Wood Turtles were seen in the hayfields they never moved far from the river.

The number of observations, and the evidence of local inhabitants seems to establish the presence of a natural population in the River Inhabitants watershed. Thus *Clemmys insculpta* may be added to the list of amphibian and reptile species that probably spread into Nova Scotia before the post-Pleistocene land bridge to Cape Breton Island was flooded. This is the fourth species to be recorded from Cape Breton Island but not from Prince Edward Island. The three in this category which are already recorded (see F. R. Cook. 1967. An analysis of the herpetofauna of Prince Edward Island. National Museum of Canada Bulletin 212. pp. 1–60) are the Mink Frog (*Rana septentrionalis,* the Pickerel Frog (*Rana palustris*) and the Four-toed Salamander (*Hemidactylium sculatum*).

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A New Record of the Fieldfare (*Turdus pilaris*) in Canada*

The Fieldfare (*Turdus pilaris*) is a Palaearctic thrush (Dement'ev et al. 1954; Voous 1960; Witherby et al. 1965) that breeds in northern Europe (Norway, east to the Aldan River in Siberia and southwards to Germany, Hungary, and Switzerland, exceptionally in eastern France and the Netherlands) and winters in central and southern Europe (rare in the Mediterranean region), and has been recorded in Northwest Africa and Egypt (Etchécopar and Hüe 1967). Salomonsen (1951) records the invasion and subsequent establishment, in 1937, of this species in Greenland. To date, the Fieldfare has been recorded on only three occasions in North America. Taverner (1940) reported that G. Rowley had presented the National Museum of Canada with a Fieldfare skin that he had obtained, in 1939, from an old Eskimo lady, who lived on Jens Munk Island, Foxe Basin, off Baffin Island, while Goodwin (1967) recorded a specimen seen near Ottawa by H. N. MacKenzie. The latter bird was later described by MacKenzie (1968). Scott and Cutler (1969) recorded a Fieldfare at the Bombay Hook Refuge, Delaware. Davis (personal communication) noted the presence of a Fieldfare at Larchmont, Westchester County, New York on 3 February 1973.

On 1 January 1973, during a final survey of the St. John's, Newfoundland Christmas Bird Count area in the count period, a large thrush (approximately the size of an American Robin (*Turdus migratorius*) was seen flying down into a *Rosa multiflora* hedge from a nearby lilac tree, in one of the older subdivisions of the town. The bird, which was feeding on rose hips, had apparently been in the area for about two weeks and was identified as a Fieldfare. The bird was seen by many observers during the following days, the authors of this paper observing the specimen (binoculars 8 × 40, 9 × 35, 8 × 30, respectively) in a wide variety of light and weather conditions, at distances as close as 30 feet, on 1 and 2 January. A black and white photograph of the bird is in the bird distribution files of the National Museum of Natural Sciences, Ottawa.

Description (from field notes) — Robin-sized bird. Head, nape, and rump light grey, crown finely streaked black. Lores and under eye black. Superciliary pale but not prominent. Back chestnut brown. Wings: upper, brownish-grey, primaries dark; lower, white, including axillaries. Throat and upper breast golden-brown, streaked black. Belly white, flanks white with bold black marks. Tail dark (appeared black). Legs and feet dark. Bill yellow with a dark tip and partially dark upper mandible.

This paper constitutes the fourth report of a Fieldfare in North America, the third one in Canada.

Literature Cited

Dement'ev, G. P., N. A. Gladkov, et al. 1954. Birds of the Soviet Union. Volume VI. Gosudarstv. Izdat. Sovetskaya Nauka, Moskva. 769 pp. (Russian text.) (Translated IPST. 1968. 879 pp.)

Etchéopar, R. D. and **F. Hüe.** 1967. The birds of North Africa. Oliver and Boyd, Edinburgh and London. 613 pp.

Goodwin, C. E. 1967. Regional reports. Winter season. December 1, 1966–March 31, 1967. Ontario — western New York region. Audubon Field Notes 21: 413–415.

MacKenzie, H. N. 1968. A possible Fieldfare observation near Ottawa, Ontario. Canadian Field-Naturalist 82: 51.

Salomonsen, F. 1951. The immigration and breeding of the Fieldfare (*Turdus pilaris* L.) in Greenland. Proceedings of the Xth International Ornithological Congress, 1950. pp. 515–526.

Scott, F. R. and **D. A. Cutler.** 1969. Regional reports. The winter season. December 1, 1968–March 31, 1969. Middle Atlantic coast region. Audubon Field Notes 23: 463–466.

Taverner, P. A. 1940. Fieldfare, an addition to the American list, and some Arctic notes. The Auk 57: 119.

Voous, K. H. 1960. Atlas of European birds. Thomas Nelson and Sons, London. 284 pp.

Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst and **B. W. Tucker.** 1965. Witherby's handbook of British birds. Volume II. Warblers to Owls. H. F. & G. Witherby Ltd., London, England. 368 pp. (Reprint of revised 1943 edition.)

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Transatlantic Migration of Dark-phase Fulmars from the European Arctic[1]

Abstract. The average bill length of a sample of 14 dark-phase Fulmars *Fulmarus glacialis,* taken off Labrador in May 1969 and 1970, was significantly longer than that of birds breeding in the Canadian Arctic. It is suggested that the majority of these birds were migrants from the European Arctic.

The Northern Fulmar *Fulmarus glacialis* is an abundant non-breeding seabird in the waters east of Newfoundland and Labrador (Fisher 1952). Most birds are in the light-plumage colorphase (Fisher's LL and L forms), and banding returns show that these come from the predominantly light-phase colonies in west Greenland, Iceland, and Britain (Brown 1970, and unpublished data). Dark-phase birds (Fisher's D and DD forms) are generally scarce. It has been assumed that these are from the dark-phase colonies of the eastern Canadian Arctic, as opposed to those in the European Arctic (e.g. Palmer 1962), but there are no banding returns to confirm this assumption.

Failing the returns, one can use morphological variations to establish the origins of these dark-phase birds. On the basis of bill length and shape, Fulmars may be divided into three subspecies (Palmer 1962). The short-billed subspecies *minor* includes light birds from west Greenland and dark ones from the Canadian Arctic; the longer-billed nominate race *glacialis* includes light birds from the eastern Atlantic and dark ones from east Greenland, Spitsbergen, Bear Island, and Franz Josef Land; light and dark birds from the north-Pacific are grouped in another long-billed subspecies, *rodgersii.* Table 1 shows average bill lengths, measured as the chord from the base of the culmen to the most distant part of the hook (see Wynne-Edwards 1952: Figure 3). These measurements provide standards against which one can compare the bill lengths of the dark birds found off eastern Canada.

On May 17, 1969, and between May 3 and May 12, 1970 I caught a total of 14 dark-phase Fulmars off southeast Labrador, between 51°20′ and 54°30′ N, and 51°00′ and 53°25′ W. These were birds attracted to fishing operations on the Fisheries Research Board of Canada's research trawler "A.T. Cameron;" they were caught in a hand-net, measured with vernier calipers, banded and released. The bill lengths are given in Table 1.

[1]An investigation associated with the program "Studies on northern seabirds," Canadian Wildlife Service, Environment Canada (Report Number 19).

The birds were not sexed, but Fulmars caught by this method are usually males; one light-phase bird caught in May 1970 was a male, as were 15 out of 20 light and dark birds caught in this area in October–November 1971. (It is not clear whether this reflects the Fulmar sex-ratio on the Labrador Banks, or some tendency for males to come closer to the ship.)

The average bill length of this Labrador Sea sample was significantly greater than that of birds from the Canadian Arctic. On a Student *t* test, the lengths differ at the 0.01 level from my own measurements of Canadian males, and at the 0.001 level from Salomonsen's (1950) and Mathiasson's (1963) measurements of males and from all measurements of females. This is unlikely to be a result of shrinkage in museum specimens; there are no significant differences between Dunnet and Anderson's (1961) bill length measurements of living and museum Fulmars. By contrast, these Labrador Sea birds are very similar to those from the European Arctic; they are significantly larger than de Korte's (1972) Spitsbergen females, and probably larger than those of Mathiasson (at the 0.001 and 0.05) levels respectively), but they do not differ significantly from the other averages. Similarly they do not differ form the Pacific males, but are significantly larger than the Pacific females ($P = 0.001$).

In other words, the average bill length of the Labrador Sea sample was too long for it to have been made up entirely or even mainly of the subspecies *minor* from the Canadian Arctic. Evidently, dark birds of one or both of the longer-billed subspecies visit Canadian Atlantic waters. Of the two subspecies, it seems unlikely that the birds I measured could have been *rodgersii*; to reach the Labrador Sea from the Pacific these birds would have to cross a thousand-mile stretch of the Beaufort Sea and the western Canadian Arctic where Fulmars are seldom or never seen (Fisher 1952; Palmer 1962). But light-phase *glacialis* regularly migrate to eastern Canadian waters, and there seems to be no obvious reason why dark-phase birds from the European Arctic should not do the same. Such migration is well known in the case of other seabirds. Thick-billed Murres *Uria lomvia* and Dovekies *Plautus alle,* banded in Spitsbergen, are regularly recovered off west Greenland, and Black-legged Kittiwakes

TABLE 1. — Bill-length measurements (mm) of Fulmars

Location	Number	Mean	Standard Deviation	Range	Source
Canadian Arctic:					
Admiralty Inlet	♂♂ 21	35.96	1.775	33.2–39.0	Salomonsen 1950
	♀♀ 6	33.08	0.631	32.3–34.0	
North Baffin Island[1]	♂♂ 33	36.2	1.6	33.2–39.0	Mathiasson 1963
	♀♀ 9	33.1	1.2	31.0–35.5	
Canadian Arctic[2]	♂♂ 19	36.63	1.163	33.2–38.1	this paper
	♀♀ 12	34.12	1.380	32.3–37.3	
European Arctic:					
Spitsbergen	♂♂ 11	38.4	1.0	36.5–40.0	Mathiasson 1963
	♀♀ 5	36.5	1.2	33.5–38.9	
Spitsbergen	♂♂ 11	37.8	1.42	36.1–40.6	de Korte 1972
	♀♀ 12	34.8	1.28	32.4–38.9	
Spitsbergen + Bear Island[2]	♂♂ 7	39.47	1.106	37.9–40.9	this paper
	♀♀ 4	37.15	0.656	36.9–38.1	
North Pacific	♂♂ 15	37.25	1.4	34.9–40.6	Wynne-Edwards 1952
	♀♀ 15	36.10	1.4	33.2–40.0	
Labrador Sea	– – 14	38.33	1.773	34.0–40.8	this paper

(Raw data: 34.0,35.8,37.6,37.7,37.7,38.3,38.3,38.6,39.2,39.2,39.4,40.0,40.0,40.8.)

[1]Salomonsen's data are included in this sample.
[2]Based on dark-phase specimens in the National Museum of Canada, Royal Ontario Museum, Royal Scottish Museum, San Diego Museum, Université de Moncton, University Museum Aberdeen, University Museum Oxford.

Rissa tridactyla, banded in the Barents Sea, have been recovered in west Greenland and Newfoundland (Salomonsen 1971; Tuck 1971).

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I should like to thank the Director, Fisheries Research Board, St. John's, Newfoundland for permission to work on the "A.T. Cameron", R. J. Wells and Captain G. Walters for their hospitality on board ship; H. Chiasson and Dr. C. E. Tull for help in catching the birds; and Dr. D. N. Nettleship for his comments on the manuscript.

Literature Cited

Brown, R. G. B. 1970. Fulmar distribution: a Canadian perspective. Ibis 112: 44–51.

de Korte, J. 1972. Birds, observed and collected by "De Nederlandse Spitsbergen Expeditie" in West and East Spitsbergen, 1967 and 1968–'69. Part I. Beaufortia 19: 113–150.

Dunnet, G. M. and **A. Anderson.** 1961. A method for sexing living Fulmars in the hand. Bird Study 8: 119–126.

Fisher, J. 1952. The Fulmar. Collins, London. 496 pp.

Mathiasson, S. 1963. Stormfåglar (*Fulmarus glacialis*) i svenska vatten, en biometrisk-morfologisk studie med syfte att klarlägga deras ursprung. Vår Fågelvärld 22: 271–289.

Palmer, R. S. *(Editor).* 1962. The handbook of North American Birds. Vol. 1. Yale University Press, New Haven and London. 567 pp.

Salomonsen, F. 1950. Genopdagelsen af Kortnaebet Mallemuk (*Fulmarus glacialis minor* (Kjaerbølling)). Dansk Ornithologisk Forenings Tidsskrift 44: 100–105.

Salomonsen, F. 1971. Recoveries in Greenland of birds ringed abroad. Meddelelser om Grønland 191: 1–52.

Tuck, L. M. 1971. The occurrence of Greenland and European birds in Newfoundland. Bird-Banding 42: 184–209.

Wynne-Edwards, V. C. 1952. Geographical variation in the bill of the Fulmar (*Fulmarus glacialis*). Scottish Naturalist 64: 84–101.

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Observations of Fulmars on Ledges in Labrador[1]

The Fulmar *Fulmarus glacialis* is a bird of the open ocean, coming to land only to nest, and is the largest petrel breeding in Canadian waters. Godfrey (1966) notes that it breeds in large colonies in the Canadian arctic islands and is "found in summer in many other parts of the Canadian Arctic west to Banks Island (rarely), north to Ellesmere Island, and commonly southward to waters off Newfoundland, but not Hudson Bay." It is also one of the commonest birds at sea off Labrador from as early as late April to late September or early October. Perhaps most interesting is the fact that despite the presence of apparently suitable nesting sites it is not known to breed on the Labrador coast (Austin 1932; Duvall and Handley 1946, 1948; Todd 1963).

This note reports observations of Fulmars (light phase) occupying cliff ledges at Outer Gannet Island (54°00′ N, 56°32′ W) on the Labrador coast and displaying behavior usually associated with breeding and/or prospecting birds.

On 29 July 1972 during a census of breeding seabirds in Labrador, five pairs and three individuals were observed sitting on cliff ledges on the southwestern side of Outer Gannet Island. No eggs or chicks were found on four ledges which were examined, but "scrapes" existed at each site, indicating regular usage. Furthermore, the tenacity of individual birds to the same site over the 2-day observation period (29–30 July 1972) suggests possible process of pair-formation and colony establishment (Fisher 1962; Palmer 1962).

Fulmars notoriously roost in the vicinity of other seabird colonies (Outer Gannet Island supports large alcid populations: Razorbill *Alca torda,* Common Murre *Uria aalge,* Thick-billed Murre *U. lomvia,* and Common Puffin *Fratercula arctica*), and so observers must carefully double check for evidence of breeding. However, all the available evidence suggests that these 'loafing' Fulmars may represent the first authenticated attempt by this species to establish a breeding colony on the Labrador coast. This possibility is further underlined by the fact that, in establishing a colony birds often prospect a locality for increasing periods over several years before they breed (Fisher 1952; Palmer 1962). Moreover, the boreal nesting Fulmar is known to have been increasing in numbers throughout its range (Fisher 1952; Salomonsen 1965), one consequence of which may be the establishment of a marginal breeding population in previously unoccupied regions where suitable habitat occurs.

This observation provides some documentation of the colonizing process. Attempts should be made to revisit the site systematically in the future.

[1]An investigation associated with the program "Studies on northern seabirds," Canadian Wildlife Service, Environment Canada (Report Number 11).

Literature Cited

Austin, O. L. 1932. The birds of Newfoundland Labrador. Memoirs of the Nuttall Ornithological Club Number 7. Cambridge, Massachusetts. 229 pp.

Duvall, A. J. and **C. O. Handley.** 1946. Report of a wildlife reconnnaissance of the eastern Canadian Arctic. Unpublished paper. Special Report from the United States Department of the Interior, Fish and Wildlife Service. 138 pp.

Duvall, A. J. and **C. O. Handley.** 1948. Second wildlife reconnaissance of the eastern Canadian Arctic. Unpublished paper. Special Report from the United States Department of the Interior, Fish and Wildlife Service. 168 pp.

Fisher, J. 1952. The Fulmar. New Naturalist Series. Collins, London. 496 pp.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin Number 203. 428 pp.

Palmer, R. S. 1962. The handbook of North American birds. Vol. 1. Yale University Press, New Haven, Connecticut. 567 pp.

Salomonsen, F. 1965. The geographical variation of the Fulmar (*Fulmarus glacialis*) and the zones of marine environment in the North Atlantic. Auk 82(3): 327–355.

Todd, W. E. C. 1963. Birds of the Labrador Peninsula and adjacent areas. University of Toronto Press, Toronto. 819 pp.

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Possible Imitative Feeding Behavior in Two Species of Woodpeckers

The method used by nuthatches to crack sunflower and other seeds with hard coats is familiar to most bird-watchers: the bird carries the seed to a tree with rough bark, wedges it into a crevice, and opens it by hammering it with its bill. I have recently observed both a Downy Woodpecker (*Dendrocopos pubescens*) and a Hairy Woodpecker (*D. villosus*) using the same technique.

On March 1, 1973, at about 8:30 a.m., at my feeder in Halifax, Nova Scotia, a Red-breasted Nuthatch (*Sitta canadensis*) which had been present there intermittently for about a week was feeding on sunflower seeds, the only food provided, as described above. Downy Woodpeckers had occasionally appeared near the feeder, but had never before been seen to take any seed. On this occasion, a female Downy Woodpecker picked seeds out of the feeder, carried them farther up the tree, a red oak, *Quercus borealis,* wedged them into a crevice, at least once the same crevice which had previously been used by the nuthatch, and hammered at it. This occurred twice. A male Downy Woodpecker and a female Hairy appeared shortly afterwards. The male Downy Woodpecker was not seen to take any seed, but the Hairy Woodpecker twice picked a seed from the feeder and attempted to crack it using the same crevice. On one occasion when the seed fell out of the crevice, the bird went to the ground, retrieved it from the snow and again attempted to wedge it into the crevice. Empty husks of sunflower seeds were later found in this and other crevices, but it was impossible to say whether the woodpeckers had succeeded in opening them, or if these were all residues of meals of the nuthatch.

I had never before seen woodpeckers treat seeds in this way, nor have I been able to find reports of similar behavior. Bent (1939. Life histories of North American Woodpeckers. Smithsonian Institution United States National Museum Bulletin 174) states that nuts and other seeds have been found in the stomachs of both of these species of woodpeckers, and quotes E. R. Tibbets' description of a Downy Woodpecker's catching in flight a nut that had been tossed into the air and subsequently cracking it. How the nut was cracked is not stated, however. Lawrence (1967. A comparative life-history study of four species of woodpeckers. American Ornithologists' Union, Ornithological Monograph No. 5) makes no mention of seed-cracking in her detailed study of woodpeckers. The purpose of the Acorn Woodpecker (*Melanerpes formicivorus*) in wedging acorns into specially drilled holes is obscure, but seems to be unrelated to cracking them open.

It therefore seems possible that the two woodpeckers seen wedging seeds into crevices were imitating the behavior of the nuthatch.

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First Authenticated Record of the Western Sandpiper for Alberta

On the morning of 16 August 1972 during a joint Canadian Nature Federation – Calgary Field Naturalists' Society field trip to the prairie region east of Calgary, the senior author identified a Western Sandpiper (*Calidris mauri*) within a flock of approximately 80 sandpipers and small shorebirds. The flock was feeding in a small mud flat slough approximately 1½ miles east of Shepard, Alberta (approximately 4 miles east of Calgary, Alberta). The bird was observed for about an hour at distances of less than 100 feet with 7-power binoculars and a 20–40 × binocular telescope. It was subsequently observed by all the authors, as well as Mr. W. Garry McKay and Dr. C. D. Bird.

The sandpiper was again seen at the same location during the evening of 17 August 1972. During this visit it was observed by Mr. Hank Vander Pol, Ms. Ruth Jones, and several others. Mr. Vander Pol, who is familiar with Western Sand-

pipers on the west coast, confirmed the identification of the shorebird in question.

During both of these observation periods it was obvious that the bill of the sandpiper in question was longer (though not obviously more downcurved) than that of the Least, Baird's, and Semipalmated Sandpipers (*Calidris minutilla, C. bairdii,* and *Calidris pusillus,* respectively) that were near by. The most distinguishing feature to many of the observers, however, was the rufus-chestnut patch high up on the wing. This was very distinct but could be seen only under perfect light conditions.

On the morning of 18 August 1972, two birds fitting the above description were observed at the same location by Messrs. William Lang, Bruce Jones, and D. V. Weseloh. A specimen was collected and submitted to Dr. W. Earl Godfrey, who confirmed the identification.

The Western Sandpiper had previously been hypothetical for Alberta on the basis of sight records at Conrich (10 miles northeast of Shepard) on 10 and 11 May 1959, and Sullivan Lake (110 miles northeast of Shepard) on 21 August 1960 (Salt, W. R. and A. L. Wilk. 1966. *The Birds of Alberta.* 2nd (revised) edition. Queen's Printer, Edmonton, Alberta; Salt, personal communication). There are additional sight records of this species from the files of The Calgary Field Naturalists' Society: single specimens were reported from Frank Lake (30 miles south southwest of Shepard) on 17 August 1968 by Messrs. W. W. Smith and J. E. (Red) Mason; and from an area 6 miles west of Strathmore (14 miles east northeast of Shepard) on 1 April 1971 by Messrs. Tom Sadler and Ian Sadler. The present report represents the first authenticated record of the Western Sandpiper in Alberta (Salt, personal communication.

W. E. Godfrey (1966. *The Birds of Canada.* National Museum of Canada Bulletin Number 203. 428 pp.) states that the breeding range of the Western Sandpiper extends from western and northern Alaska to Camden Bay (on the Arctic Ocean near the Alaska-Yukon Territory border). It winters coastally from southern North America to northern South America. In Canada it is common only as a spring and fall transient on the coast of British Columbia. In the interior it is scarce, mainly appearing as an autumn transient.

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A Northern Record of the Nashville Warbler in British Columbia

On the evening of 30 April 1972, an adult male Nashville Warbler *(Vermivora ruficapilla ridgwayi)* was struck by our car and killed about 20 miles south of Prince George, British Columbia (122°7′ W, 53°9′ N). The bird was flying from a brushy willow thicket on one side of the road to the same type of habitat on the other side.

Earlier northern records for this species are specimens from Clearwater, British Columbia (Munro, J. A., and I. McT. Cowan. 1947. British Columbia Provincial Museum Special Publication Number 2: 191) and from Pemberton and Lillooet, British Columbia (Godfrey, W. E. 1966. National Museum of Canada Bulletin Number 302: 324).

This new specimen represents the northernmost known occurrence of the species in British Columbia. The specimen was deposited in the University of British Columbia Vertebrate Museum (Number 13722).

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A Northern Range Extension for the Pika in the Northwest Territories

While conducting behavior experiments with Dall sheep, *Ovis d. dalli,* from July 1 to July 14, 1972 in the Northwest Territories, we discovered and photographed a colony of pika, *Ochotona* sp.

The colony was located north of the Arctic Circle, at 67°54′ N latitude and 136°08′ W longitude, in the Richardson Mountains. The site inhabited by the pikas was a rock slide at 850 m elevation, and oriented northwest-southeast between Bear Creek and Fish Creek.

Our observations agreed with those of Broadbooks (1965) in that the pika, being an ecotone species with its home in one habitat and food supply in another, inhabited the borders of the rock slides rather than the center. There was evidence of numerous pika trails from the rocks into the adjacent meadows below. Intensive surveys to determine the density of the colony were not conducted. However observations of pikas along the edge of the rock slide indicated that individuals were spaced approximately 100–200 feet apart. This appears to approach the density for pikas reported by Broadbooks (1965).

Vegetative cover adjacent to the rock slide consisted of typical alpine tundra with intermixed dwarf willow (*Salix* sp.) and black spruce (*Picea mariana*), these becoming more abundant on the alpine meadow sloping gently below the colony to a creek draining the valley. Above the pika colony the talus slopes extended approximately halfway up the ridge. Stratified rock outcroppings and cliffs constituted the higher elevations of the ridge.

The habitat in which this pika colony occurred is typical of that described by Hall and Kelson (1959), Cockrum (1962), and Burt and Grossen-

FIGURE 1. Distribution of the collared pika *Ochotona collaris,* showing range extension.

heider (1964). This is also true of the descriptions offered by Broadbooks (1965) and Haga (1960) on pika habitat. Haga (1960) also noted that terrain is more a limiting factor in pika distribution than altitude, temperature, or food.

Hall and Kelson (1959), Cockrum (1962), and Burt and Grossenheider (1964) have all reported the northern limit of pika distribution to be the Yukon River in Alaska and approximately 65° north in the Yukon and Northwest Territories. The general range described by these authors is illustrated in Figure 1, and compared with the location of the pika colony which we discovered. Mr. P. M. Youngman (personal communication), National Museum of Natural Sciences, Ottawa, Canada has recorded a pika colony approximately 30 miles southwest of this location. This indicates that the distribution of pikas is probably continuous along the Richardson Mountains, extending from the previous northern boundary of their range to well north of the Arctic Circle.

Numerous aerial survey flights in the northern Yukon during 1972 indicated apparently suitable habitat for pika in the Ogilvie, Wernecke, Keele, and Richardson Mountains. More significant were similar observations for the North Richardson and British Mountains north of 68° latitude. In all probability the northern limit of the pika has yet to be found pending future investigations in the North.

No specimens were collected from this colony. However, the photographs taken and the location of the colony would indicate these pika to be of the species *O. collaris* as described by Hall and Kelson (1959), and Burt and Grossenheider (1964). Broadbooks (1964) states that *O. collaris* and *O. princeps,* of the Rocky Mountains in Canada and the United States, may be of a single species *O. princeps,* because of minor differences in morphology, ecology, and behavior.

The pika colony was discovered while field studies were being conducted for Canadian Arctic Gas Study Limited by Renewable Resources Consulting Services Limited.

Literature Cited

Broadbooks, H. E. 1965. Ecology and distribution of the pikas of Washington and Alaska. American Midland Naturalist 73: 299–335.

Burt, W. H. and **R. P. Grossenheider.** 1964. A field guide to the mammals. Houghton Mifflin Company, Boston. 284 pp.

Cockrum, E. L. 1962. Introduction to mammalogy. Ronald Press Company, New York. 455 pp.

Haga, R. 1960 Observations on the ecology of the Japanese Pika. Journal of Mammalogy 41(2): 200–212.

Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America. Volume I. Ronald Press, New York. 1083 pp.

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The Pitcher Plant *Sarracenia purpurea L.* in the Northwestern Part of its Range[1]

Sarracenia purpurea is a conspicuous and abundant plant in many of the bogs in eastern Canada. In the southern part of the District of Mackenzie, and in the northern parts of British Columbia and Alberta, however, although the habitat occupied by this species is seemingly very common, the Pitcher Plant is indeed a rare plant.

[1]Contribution No. 968 from the Plant Research Institute, Canada Department of Agriculture, Ottawa.

John Richardson (1823) recorded *Sarracenia purpurea* as "(W.)." This denoted that he found it in the wooded country from latitude 54° to 64°. This symbol did not mean that the plant occurred throughout these 10 degrees of latitude as some authors have interpreted, but only that it occurred somewhere within that zone. Thus W. J. Hooker (1829) wrote "Probably common throughout Canada, and as far north as Bear Lake. *Dr. Richardson. Drummond*". The only Richardson specimen

that is known from this area was collected at Fort Chipewyan at the west end of Lake Athabaska in latitude 58°42′ N, in what is now the province of Alberta (Raup 1936). This specimen was cited by MacFarlane (1908) in his monograph of the Sarraceniaceae and is probably preserved at Kew. Raup substantiated its occurrence in the Lake Athabaska region when he collected *Sarracenia purpurea* in a muskeg near Ennuyeuse Creek on the south shore of Lake Athabaska in Saskatchewan. In spite of the fact that it had been searched for diligently for many years by one of the authors (W.J.C.), there were no specimens specifically recorded from the District of Mackenzie. Thus *S. purpurea* was listed by Porsild and Cody (1968) as a species which was unknown but might yet be discovered in the Continental Northwest Territories.

It was therefore of considerable interest when two collections were made from widely separated localities in the District of Mackenzie during the summer of 1971. Data are as follows. MACKENZIE DISTRICT: seismic line in a *Triglochin maritimum* marsh, 1.3 miles south of Mile 92 Mackenzie Highway, 60°54′ N 116° 55′ W, *S. Talbot s.n.*, 27 July 1971 (DAO); common on a level burned part of the peat plateau, fairly moist, with *Andromeda, Smilacina trifolia,* and *Menyanthes,* Rabbitskin Creek about 14 miles east of the Mackenzie River, 61°45′ N 120°15′ W, *J. S. Rowe 1910,* 16 July 1971 (DAO).

At the first site, *Sarracenia purpurea* was abundant in *Scorpidium*-dominated, eutrophic wet-level fen apparently similar to a 'Rimpibaunmoor" (Ruuhijärvi 1960). This is quite different from the *Sphagnum* peat situations in which the Pitcher Plant is frequently found. Here the dominant species were *Scorpidium scorpioides, Scirpus caespitosus, Menyanthes trifoliata, Carex limosa, Campylium stellatum, Myrica gale, Drosera angli,-ca, Andromeda polifolia, Triglochin maritimum,* and *Equisetum fluviatile.*

FIGURE 1. The northwestern distribution of *Sarracenia purpurea* as known from herbarium specimens and reliable literature records. The discounted site at Edson, Alberta is indicated by an open circle.

The presence of *Sarracenia purpurea* in the District of Mackenzie is now confirmed.

Macoun (1883) gave the distribution ". . . and Nova Scotia to the Rocky Mountains . . ." for *Sarracenia purpurea.* Raup (1936) gave the following information: "In his long list of plants observed in 1875 John Macoun includes the pitcher plant in his section IV, 'Peace and Athabaska Rivers east of the Rocky Mountains,' but no specimens are available to support his record." There are indeed no specimens of *S. purpurea* from either Alberta or British Columbia in the herbarium of the National Museum of Canada, collected by Macoun or anyone else. Wherry (1933) stated "Its northwestern limits are still uncertain; Hooker reported it to occur on Bear Lake, and several compilers of manuals and floras have attributed it to the Canadian Rocky Mountains, but no specimens from these regions are extant."

In the northeastern section of Alberta *Sarracenia purpurea* has now been collected three times besides the original collection by Richardson: Fort McMurray, *A. Kahil* (ALTA, DAO); Anzac, *G. Milton* (ALTA, photo DAO) — reported by Boivin (1969); and 5 miles east of Richardson Lake, *M. Stick* (ALTA).

There is also a report of this species from Edson, west of Edmonton (Moss 1959) which was repeated by Krajina (1968). This locality is far outside the limit of the boreal forest where *Sarracenia purpurea* might be expected, and thus, because of the absence of a supporting voucher specimen, must be discounted.

There is only one known locality for the Pitcher Plant in British Columbia. This is a peat bog approximately 20 miles south of Fort Nelson in the extreme northeastern part of the province. A specimen collected here in June 1968 by *R. M. Annas* (UBC), was reported by Krajina (1968).

In his paper, Krajina (1968) gave a distribution map, based largely on the treatment by Wherry (1933), which in the western part was quite sweeping and thus inaccurate, as shown by the above information. For this reason a dot map depicting the northwestern distribution of *Sarracenia purpurea* is presented with this note. (Figure 1).

Acknowledgments

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Literature Cited

Boivin, B. 1969. Flora of the prairie provinces. Part 2. Provancheria 3.

Hooker, W. J. 1829. Flora boreali-Americana. Volume 1. Part 1. Henry G. Bohn, London.

Krajina, V. J. 1968. Sarraceniaceae, a new family for British Columbia. Syesis 1: 121–124.

MacFarlane, J. M. 1908. Sarraceniaceae. Das Pflanzenreich 4: 110:34.

Macoun, J. 1883. Catalogue of Canadian plants. Part 1. Dawson Brothers, Montreal.

Moss, E. H. 1959. Flora of Alberta. University of Toronto Press, Toronto.

Porsild, A. E. and **W. J. Cody.** 1968. Checklist of the vascular plants of Continental Northwest Territories. Plant Research Institute, Canada Department of Agriculture, Ottawa. 102 pp.

Raup, H. M. 1936. Phytogeographic studies in the Lake Athabaska – Great Slave Lake Region. I. Catalogue of the vascular plants. Journal of the Arnold Arboretum 17: 180–315.

Richardson, J. 1823. Botanical appendix to Franklin's narrative of a journey to the shores of the Polar Sea in the years 1819, 20, 21 and 22. John Murray, London.

Ruuhijärvi, R. 1960. Uber die regionale Einteilung der nordfinnischen Moore. Annales Botanici Societatis Zoologicae-Botanicae Fennicae "Vanamo" 31(1): 1–360.

Wherry, E. T. 1933. The geographic relations of *Sarracenia purpurea.* Bartonia 15: 1–6.

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White-crowned Sparrow Breeding at Deception Bay, Nouveau-Québec

During the summer of 1972, Bider made ornithological field investigations in the Deception Bay area, northwestern Quebec. While emphasis was primarily on the nesting of birds of prey, observations on other species were recorded of which the most notable was the following.

On 21 July, a nest of the White-crowned Sparrow (*Zonotrichia leucophrys*) was found some 600 yards (550 m) west of the townsite of Deception Bay. It was located on the ground in a slight depression, under a willow about to leaf out. The nest, made of fine grass, contained three nestlings fully feathered on the back. The adults were seen bringing food to the young.

The range of the species in northern Quebec covers most of the Ungava Peninsula as outlined by Godfrey (1966, pp. 396–397) and Todd (1963, pp. 688–697), and extends north to Lake Maryland at 60°27′ N, 73°20′ W (Eklund 1956, p. 74), and to the Kovic Gorge at 61°39′ N, 77°28′ W (Manning 1949, pp. 214–215). The present record thus extends the breeding range of the species northwestward to Hudson Strait.

Literature Cited

Eklund, Carl R. 1956. Bird and mammal notes from the interior of Ungava Peninsula. Canadian Field-Naturalist 70(2): 69–76.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada, Bulletin Number 203. 428 pp.

Manning, T. H. 1949. The birds of northwestern Ungava. *In* A summer on Hudson Bay. Mrs. T. H. Manning. Appendix. pp. 155–244.

Todd, W. E. C. 1963. Birds of the Labrador Peninsula and adjacent areas. University of Toronto Press, Toronto. 819 pp.

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An Association of a Calf and Bull Moose

Little is known concerning survival of orphaned moose calves, *Alces alces,* when they are left alone after their dam is shot during either sex hunting seasons.

Calf moose normally remain bonded to their dam until arrival of the new calf the following spring (Altmann. 1958. Animal Behavior 6: 155–159). The strong maternal, protective instinct of the cow moose has been considered as a factor which enhances survival of the calf (de Vos, Brokx, and Geist. 1967. American Midland Naturalist 77: 390–417). This note reports observations of a moose calf associating with a bull moose at a time of year when the calf normally would have been still with its dam.

On 13 October 1971 a calf and bull moose were observed together, with no other moose evident, near Roche Lake in a semi-remote region of central Alberta. The two animals were seen a second time in the same area on 21 December 1971. The bull was identified as being the same animal by its size and by the configuration of its antlers. It was believed that the calf had been orphaned when its mother was shot by hunters earlier. The three-month either sex hunting season opened 7 September in 1971 in that area.

Altmann also idicated that calf moose displayed interest in the rutting bulls which approached their dams and that bulls usually tolerated the presence of the calves. The association between the calf and bull moose may have enhanced the survival of the calf, in the absence of the protective instinct of the dam.

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A Nesting Study of a Small Population of Prairie Falcons in Southern Alberta

During spring and summer of 1967 through 1971, observations were made of Prairie Falcons (*Falco mexicanus*) nesting within a 20-mile radius of Calgary. The study was carried out on a part-time basis, and because of this the history of some of the nest sites is incomplete. It is the author's hope that the information will be useful to others interested in the preservation of raptors.

Methods

In 1967, 10 nest sites, known to have been used previously, were selected. Observations consisted of visits to the eyries and no intensive observation at a distance was attempted. Most visits were made in the evening and were kept as short as possible, so as to minimize the disturbance of the birds. (The methods have been described previously, Edwards 1968). The number of visits to each eyrie was dictated by its location, but an attempt was made to visit each nest as close to the same number of times as possible. (Approximately five visits per active nest site per year.)

In the first year of the study, stakes requesting that the nests be left undisturbed were placed near the eyrie and were appropriately inconspicuous.

One egg was collected from each of five nest sites in 1967 for pesticide analysis by the Canadian Wildlife Service.

Results and Discussion

During the five years (for which there was a total of 50 nesting possibilities at 10 nest sites) nesting was in fact attempted (eggs laid) in only 25 instances. Two sites occupied by pairs (nest sites 4, 1967; 6, 1969) lost one member of a pair during the nesting season. One nest site was occupied in one year by a pair which apparently did not attempt to nest. I have no conclusive data for nest site 8 in 1971. In the other 23 nesting possibilities nest sites failed to be occupied by pairs. In two of these instances sites were occupied by single birds (one of which was identified as an adult female). In none of these cases did pairing or re-pairing occur during that season. By contrast, Enderson (1964) noted that "at no site did a falcon remain unmated."

Eggs

The average clutch size of 20 observed clutches was 4.5 eggs. Five-egg clutches were the most common, 11 being observed. Seven four-egg clutches were laid and there was only one six-egg clutch. One egg was found at nest 9 in 1971, although no adults were located and the egg subsequently disappeared. One egg was taken from each of nest sites 1–5 in 1967 for pesticide analysis. During 1967, 1.4 young per eyrie were fledged at sites 1–5, a number slightly lower than the 5-year overall average. However, the overall average in 1967 was 1.7 higher than the overall 5-year average. Of 85 eggs that could have hatched at least 16 did not.

Five clutches of eggs disappeared. Four were replaced, two being replaced by the same number of eggs. The fifth clutch, containing five eggs, disappeared but was not replaced, possibly as a result of the death of the male (nest site 6, 1969).

Although no concrete evidence was available that these five clutches were removed by humans there were signs of human activity around many of the eyries. Further, it seems unlikely that entire clutches would disappear, with no sign of eggshell remains, as a result of nonhuman predators.

Nestlings and Fledglings

During the five years, it was not possible to discover exactly what the maximum number of nestlings was since visits to eyries often could not be made immediately following hatching.

Of the 21 nestings that successfully fledged young, 12 nest sites were observed (1967: sites 1, 2, 3, 5, and 6; 1968: sites 4 and 5; 1969: site 9; 1970: sites 6 and 9; 1971: sites 3 and 4) immediately after hatching and again when the young were from 10 to 15 days of age. At only one of these nest sites (number 3, 1967) was the number of young reduced during this period of nestling life. Therefore this could be considered one of the least critical times in the nest life of the young.

Also at this stage (early June) there was evidence to suggest that a shift occurred in prey taken by the adults from mainly birds (20 species recorded at the eyries) to mainly Richardson's

ground squirrels (*Citellus richardsonii*), possibly in response to increased demands for food by the young.

As can be seen from Table 1, approximately half the observed nestlings were also observed as fledglings in all years except 1969 when the number of fledglings was approximately one-third the number of nestlings.

It is difficult to say exactly how many young are fledged since they are often dispersed for a considerable distance after vacating the eyrie. However, at a certain time when the young were competent flyers they participated in the territorial displays of the adults, at which time they could be counted.

As Table 1 indicates, the average number of young fledged per pair which laid eggs was 1.6, which was higher than the 1.37 recorded by Enderson (1964) for this species in Colorado and Wyoming.

Nest sites 3 and 6 (Table 1) accounted for 20 fledglings or over half of all the young fledged.

Mortality Factors

No dead nestlings or fledglings were found, and generally the mortality factors can only be speculated upon. Evidence of human disturbance at eyries was noted several times (sticks in eyries, etc.), and this may be a factor in disappearance of young, although the importance of this disturbance is unknown.

It is possible that visits by humans to the eyries late in the nestling phase could increase the hazards for newly feathered but nonflying young, since they may be caused to leave the eyrie before they are capable of flying to safe roosts. In such cases they might be vulnerable to coyotes (*Canus latrans*), badgers (*Taxidea taxus*), dogs (*Canis familiaris*), and Great Horned Olws (*Bubo virginianus*).

The influence of organochlorine insecticides does not appear to be as great in this area as in other prairie regions, since total egg residue from eggs collected from eyries 1–5 in 1967 was relatively low. Fyfe et al. (1969) indicate the mean egg residue (in parts per million wet weight) for this general area is 2.09, as compared with mean residue levels of 5.16, 8.13, and 8.45 for other areas in Alberta and Saskatchewan.

Conclusions

Despite the fact that the yearly production of fledged young in the study area appears to be sufficient to maintain this population, only half

TABLE 1. — Nest site productivity

Nest site	1967			1968			1969			1970			1971			Total		
	E	N	F	E	N	F	E	N	F	E	N	F	E	N	F	E	N	F
1	(4)*3	1	1	Unoccupied			Unoccupied			Unoccupied			Unoccupied			4	1	1
2	(5)4	4	3	Unoccupied			Single Bird			Unoccupied			Unoccupied			5	4	3
3	(5)4	4	2	5	3	2	6	5	2	5	4	3	5	5	2	25	19	11
4	(5)4	0	0	5	4	1	Unoccupied			Unoccupied			Unoccupied			10	4	1
5	(5)4	1	1	5	5	2**	Unoccupied			Unknown			?	3	?	10††	11††	4††
6	4	4	2	4	3	2	5	0†	0	4	1	1	4	4	4**	21	12	9
7	?	?	3	Unoccupied			Unoccupied			5	4	1	Single bird			5††	4††	4
8	?	2	2	Unoccupied			Unoccupied			Pair not nesting			Unknown			?	2	2
9	Unoccupied			?	2	2	5	4	1**	4	2	1	1	0	0	10††	8	4
10	Unoccupied			Unoccupied			Unoccupied			Unoccupied			Unoccupied			0	0	0
Total	(28)23††	22††	14	18††	17	9	16	9	3	18††	13††	7	10††	12	6	90††	61††	39
Average	(4.7)3.8	2.7	1.7	4.5	3.4	1.8	5.3	3.0	1.0	4.5	2.6	1.4	3.3	3	2	4.5	2.5	1.6

E = eggs; N = nestlings; F = fledglings (capable of flying several hundred yards).
*One egg from each of nest sites 1–5 taken for pesticide analysis.
**Fledglings barely flying.
†Adult male found dead at foot of cliff.
††Figure given too low, but exact number unknown.

the eyries occupied in 1967 were occupied in 1971. The cause of the marked fluctuation in population is not known with certainty. The loss of eggs and possibly of older young is probably due mostly to human interference.

I speculate that human disturbance of Prairie Falcons early in the nesting season has a great impact on nest-site occupancy.

Acknowledgments

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Literature Cited

Edwards, B. F. 1968. A study of the Prairie Falcon in southern Alberta. Blue Jay 26: 32–37.

Enderson, J. H. 1964. A study of the Prairie Falcon in the central Rocky Mountain region. Auk 81: 332–352.

Fyfe, R. W., J. Campbell, B. Hayson, and **K. Hodson.** 1969. Regional population declines and organochlorine insecticides in Canadian Prairie Falcons. Canadian Field-Naturalist 83(3): 191–200.

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Northern Records of the Mockingbird in Alberta

Lewin (1965. A new northern record for the Mockingbird, *Mimus polyglottos*. Canadian Field-Naturalist 79(3): 208) listed the then known occurrences of the Mockingbird in Alberta and added a new northern record from Edmonton. Since the time of his writing a pair of Mockingbirds raised young successfully near Provost, Alberta, in 1964, and in November of that year another sighting was made near Pigeon Lake (Salt and Wilk. 1966. The birds of Alberta 2nd edition p. 324).

On November 26, 1972, Mrs. Peter Macyk of Thorhold, 40 miles northeast of Edmonton, telephoned me to say she had had a Mockingbird in her garden since the previous September. The bird had stripped an elder bush of berries and was then living mainly on suet supplied at a bird feeder.

On December 2, 1972, in company with four other members of the Edmonton Bird Club I visited the Macyk home and found the bird extremely active in spite of temperatures that had fallen to 1–17°F in Thorhild on the previous night. Mrs. Macyk said, however, that the bird carried its tail much less jauntily than when the weather was milder.

The cold weather continued and on December 4, 1972, the bird was seen to collapse and fall from the feeder. It was taken into the house where it remained in a comatose condition until the following day when it revived and took food.

The Macyk family was going on holiday, so the bird was taken to the Storyland Zoo in Edmonton where it succumbed in January. Unfortunately the bird was not retained as a specimen nor was its sex determined before disposal of the carcass.

Except for an occasional twitter this Mockingbird was silent for the more than two months it spent at Thorhild. It did not proclaim a winter territory by song.

The few records of Mockingbirds in the Edmonton area have all been of autumn birds. This may suggest they were birds of the year carried farther north than normal in pre-migratory wanderings.

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Unusual Winter Movements of Common Ravens and Clark's Nutcrackers

The winter of 1972–1973 saw unusual wanderings of Common Ravens, *Corvus corax,* into the parklands of Alberta. Ravens, singly and in flocks of up to 15 birds, were recorded in this area from late September to early March.

There was also a remarkable movement of Clark's Nutcrackers, *Nucifraga columbiana,* east from their breeding grounds in the Rockies. The first report came from Edmonton on November 12, 1972. After this, nutcrackers were recorded at intervals throughout the winter from such widely separated places as Lac Ste. Anne, Grande Prairie, and Fort McMurray.

Common Ravens breed across northern Alberta and down the mountains of that province. In winter there is usually some wanderings from the breeding grounds. *The birds of Albetra* (Salt and and Wilk. Revised edition. 1966), speaking of the raven, says in part, "At this season [winter] it regularly gets as far south as Lac La Biche and Athabasca. Ocacsionally it wanders much farther; during mild winters it has been seen in the Edmonton and Mundare districts and in August, 1965, one was seen near Pigeon Lake."

On September 24, 1972, Dick Dekker, a frequent contributor to this journal, saw three Common Ravens at Beaverhills Lake, some 45 miles southeast of Edmonton. On October 22, 1972, he saw another at the same lake. Subsequently, through a weekly column on birds that I write in the *Edmonton Journal,* I received several reports of ravens in the parklands, some of the significant ones of which are listed below.

On November 22, 1972, two ravens appeared at Lake Wabamun, 40 miles west of Edmonton. From then on throughout the winter, ravens in twos and threes were seen almost daily at this lake.

A report from Drayton Valley, 60 miles southwest of Edmonton on December 8, 1972, told of six ravens that had frequented the townsite for several days.

Mr. and Mrs. H. Horton, members of the Edmonton Bird Club, visiting Elk Island National Park, 25 miles east of Edmonton on January 4, 1973, saw a flock of 15 ravens. One had been noted there a week previously.

On January 14 a correspondent at Rockfort Bridge, 80 miles northwest of Edmonton, commented on the number of ravens in that area. Ravens had been seen almost daily for a month, with as many as five seen together.

Single ravens were seen in and around Edmonton on several occasions during January 1973.

The Edmonton Natural History Club in its monthly newsletters carried 10 additional sightings of between one and four birds. The most interesting of these came from Smoky Lake on 21 November 1972, from Andrew on 18 December 1972, and from Vermilion on 23 December 1972.

The weather over central Alberta was generally mild all winter, with January and February temperatures well above average. The only inclement weather was the hard, early frosts and snow around the time the first ravens were reported. The effect of mild weather on the winter wanderings of ravens may be debatable but the early arrivals could hardly be affected by weather two months are more away.

Clark's Nutcracker breeds in the subalpine coniferous forests of southwestern Alberta. In winter it descends to the valleys. Occasionally it wanders east as far as southern Saskatchewan and southern Manitoba (Godfrey, W. E. 1966. *The birds of Canada.* National Museum of Canada Bulletin 203). *The birds of Alberta* lists but three sightings outside the mountains in that province. These are from the Porcupine Hills, Beaverlodge, and Belvedere. I have one other from Edmonton in early December 1968.

On November 12, 1972, a Clark's Nutcracker appeared at a bird feeder in Edmonton. Seen by several observers, this bird remained in the vicinity for the rest of the month. It, or another nutcracker, was seen at intervals in various parts of Edmonton throughout December 1972. On March 3, 1973, a nutcracker again arrived at the feeder where the first bird had been seen. In contrast to the almost silent bird that visited the feeder in November, the March bird was extremely noisy.

After a note had been published in the *Edmonton Journal* on the appearance of the November nutcracker, I received the following reports:

12 November 1972, Carvell Corner, 30 miles west of Edmonton; 14 November 1972, Gunn, on Lac Ste Anne; 16 November 1972, Grande Prairie; 17 November 1972, 20 miles southwest of Edmonton; 17 November 1972, Gleneois, 40 miles northwest of Edmonton; 15–20 November

1972, Fort McMurray; 24 November 1972, Seba Beach, Lake Wabamun.

All the above reports are of single birds; most of the records were made by competent observers. The correspondents at both Grande Prairie and Fort McMurray did not know the nutcracker until they read my description. Both of these reports were accompanied by photographs for identification.

On February 4, 1973, a letter from Leslieville, 10 miles east of Rocky Mountain House, mentioned two Clark's Nutcrackers that had regularly visited a bird feeder there all winter.

It is interesting to note that Steller's Jay, *Cyanocitta stelleri,* another corvid from the mountains that has appeared in Edmonton in winter on several occasions in the past, was not recorded in this area in 1972–1973.

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News and Comment

Notice

To Individual and Family Members Not Resident in the Ottawa Area

Trail & Landscape is a non-technical publication of The Ottawa Field-Naturalists' Club. It includes articles on Ottawa-area natural history as well as Club news items. It will be sent to you at no cost if you request it in a letter to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada K1Y 4J5. *Librarians should note* that this does not apply to institutional subscribers.

New National Wildlife Area in Southern Ontario

The 1,450 acre Big Creek Marsh on Lake Erie, near Port Rowan, Ontario, has been purchased by the federal government in a continuing program to preserve wetlands for waterfowl. The land was bought from the Toronto and Big Creek Shooting Club. The marsh (a portion of the delta formed by Big Creek at the base of Long Point Peninsula) provides food and rest for thousands of ducks during spring and fall migration. In addition, it is a moulting area for ducks in the summer, and a famous resting place for migrating whistling swans in spring.

A management plan will be developed by the Canadian Wildlife Service and the Ontario Ministry of Natural Resources. A federal-provincial committee formed for this purpose will consider recommendations on the use of the area from such special interest groups as naturalists and hunters.

The Canadian Wildlife Service has embarked on a program to create national wildlife areas for the protection and improvement of waterfowl habitat in many parts of the country. There are now about 20 national wildlife areas in seven provinces and the Canadian Wildlife Service is looking into other possibilities. Most of these areas are migration stopovers but some are waterfowl breeding grounds.

Grant for Study of the Eastern Panther

Bruce Wright has received from an anonymous reader of his book "The Eastern Panther" (Clarke Irwin. $6.50. See review on page 332) $1,500 to help with his study of this elusive wild cat. Wright's book details hundreds of sightings of the panther long believed extinct in the eastern provinces. He is using the grant to try to get photographic proof that the eastern panther is alive and well in Nova Scotia, Quebec, and even Ontario, although it is retreating further and further into the forests. Wright is Director of the Northeastern Wildlife Station at the University of New Brunswick in Fredericton.

Canadian Mammals Listed in the Red Data Book*

The International Union for the Conservation of Nature and Natural Resources has completely revised (December 1972) its Red Data Book on the rare and endangered species of mammals throughout the world. The Canadian list is:

Wolf, *Canis lupus* — vulnerable

Northern kit fox, *Vulpes velox hebes* — endangered

Glacier bear, *Ursus americanus emmonsii* — rare

Barren-ground grizzly bear, *Ursus arctos richardsoni* — rare

Polar bear, *Ursus maritimus* — vulnerable

Black-footed ferret, *Mustela nigripes* — endangered

Bighorn sheep, *Ovis canadensis* — vulnerable

Eastern cougar, *Felix concolor cougar* — endangered

For a more complete list consult N. S. Novakowski's article *Endangered Canadian Mammals* in The Canadian Field-Naturalist 84: 17–23, 1970.

*In Special Supplement to the IUCN Bulletin 4(4) April 1973.

Book Reviews

BOTANY

The Physiology of Flowering Plants: Their Growth and Development

By H. E. Street and H. Öpik. American Elsevier Co., New York. 1970. 263 pp. $5.95 paper, $11.75 cloth.

This book, one of a series of student texts in contemporary biology, is a difficult one to read. The presentation reflects standards appropriate either to reference works or to text books of bygone eras. The wording, printed 1.5-mm type, has been packed into as few pages as possible. The result is a somewhat oppressive document — one which is unlikely to encourage even the most eager student to read further than required for immediate obligatory requirements.

The authors emphasize that the text is intended as an introduction to the many problems posed by the growth and development of the whole organism. However, the authors fail to indicate why the book is needed. This is something that should have received attention in view of the numerous texts which deal with the essentials of the same subject, and which have been published during the last few years.

Laudably, the narrative is not cluttered with excessive facts, figures, and references. However, the text does contain a number of oversimplifications and inaccuracies. For example, it is an oversimplification to state that "the cooling effect of evaporation is rather small" (p. 63) without having considered what the leaf temperature would have been without evaporation. Furthermore, it is incorrect to state that "the major resistance in the path of the flow of water from the root surface to the external atmosphere is evaporation into the air space system of the leaf" (p. 63).

The text also makes use of outdated units and terminology. A variety of units are used rather than the appropriate International System unit, and water relations are discussed in terms of diffusion pressure deficit and its components rather than of water potential. The International System of units is mentioned in an appendix, and a conversion table is provided. It is nonetheless regrettable that the opportunity to familiarize students with up-to-date and unambiguous units and terminology was not taken, especially when this could have been achieved by minor editorial attention.

The book thus has a number of shortcomings. It has little to recommend it in preference to others which fill the same niche.

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Intermountain Flora, Vascular Plants of the Intermountain West, U.S.A. Volume 1. Geological and Botanical History of the Region, its Plant Geography and a Glossary. The Vascular Cryptogams and the Gymnosperms.

By A. Cronquist, A. H. Holmgren, N. H. Holmgren, and J. L. Reveal. Published for the New York Botanical Garden by Hafner Publishing Co., Inc., New York and London. 1972. 270 pp. Available in Canada from Collier-MacMillan Canada Limited, Don Mills, Ontario. $19.25.

This is the first of six proposed volumes on the plants of the dryland region of the United States, which lies between the Sierra Nevada on the west and the Rocky Mountains on the east. The area comprises all of Utah, most of Nevada, southern Idaho, southwestern Oregon, and small parts of eastern California, northern Arizona, and southwestern Wyoming.

About one quarter of the text is occupied by an excellent and critical treatment of the ferns and fern allies (by A. Cronquist) and gymnosperms by A. H. and N. H. Holmgren). This includes keys, descriptions, synonomy, bibliographic data, and a wealth of distributional and other valuable information for each species. Excellent line drawings which depict both the fine detail of diagnostic characters as well as habit and general outline accompany each species. Many of the drawings appeared in the *Flora of the Pacific Northwest* by Hitchcock et al. These were executed by Jeanne R. Janish. New drawings required for this flora were done mostly by Mrs. Janish, but also by Kay H. Thomas and Alma Hochhauser.

The remainder of the text comprises a short introduction; a section on the physiography of the Intermountain Region by William D. Tidwell; a section entitled Evolution of Floras in the Intermountain Region by Tidwell, Samual R. Rush-

forth and David Simper; a history of botanical exploration by Reveal; and a treatment on plant geography by Noel Holmgren.

The section on Evolution of Floras is a brief summary of what is known of the plants which occurred in the region from the Early Paleozoic through to the Quaternary Period. This is a most interesting innovation and introduction to a modern flora.

The work of botanical exploration is presented with great detail and obviously as the result of much research. Maps of the travels of the earlier collectors will be most useful to monographers trying to plot the localities of various plant specimens which have heretofore been difficult to find. The pictures of the plant collectors of the region from Nathaniel Wyeth and Thomas Nuttall through to those of the present day give the reader a closer feeling for those individuals.

About a third of the text is taken up with a rather detailed study of the plant geography of the Intermountain Region. An attempt is made to subdivide the region into natural areas that can be recognized by vegetative, floristic and/or physiographic features. Four divisions which are further divided into a total of sixteen sections are described, and lists of endemic species are included. Students of the flora of this floristic province with its extremely varied terrain will find this section invaluable.

Intermountain Flora replaces the much less useable *Flora of Utah and Nevada* which was published by Ivar Tidestrom in 1925. It will be the standard work on the flora of this region for many years and should be in the library of anyone interested in plants of western North America. It is hoped that the remaining five volumes will follow quickly.

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Michigan Flora. A guide to the identification and occurrence of the native and naturalized seed-plants of the state. Part I. Gymnosperms and Monocots.

By Edward G. Voss. Cranbrook Institute of Science and University of Michigan Herbarium. 1972. xiv + 488 pp. 345 line drawings, 723 distribution maps, 8 color plates. $7.50 (US). Bulletin 55 of Cranbrook Institute of Science, Bloomfield Hills, Mich.

Descriptive floras such as *Gray's Manual of Botany* and *New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada* may be used for identifying plants from Michigan, and it is to this type of flora that one must turn for detailed descriptions of all levels of taxa for this area. *Michigan Flora* is, however, the first attempt, other than an annotated list published in 1905, to produce a treatment of only those plants found in the State of Michigan. This first volume treats only the Gymnosperms and Monocots. Two additional volumes are contemplated to cover the Dicots. A separate volume written by Cecil Billington on the *Ferns and Fern Allies of Michigan* was published by the Cranbrook Institute of Science in 1952.

The text comprises a short introduction which outlines the scope of the work, some geographical features, previous botanical work and herbaria where specimens may be found, the occurrence of plants in Michigan, notes on taxonomy and nomenclature, directions on how to use the keys, a bibliography, and the flora proper. This later part, other than the keys, differs from the conventional floras as mentioned above, by the absence of detailed descriptions. For each species there is a map reference, a reference to a figure if present (about half are illustrated by line drawings taken from various sources), notes on habitat, and in the case of rare species, the counties in which they occur are listed. Occasionally specimens are cited where they are of particular interest. Perhaps the most valuable part of the text however are the easily flowing notes which tell of associated species, where problems exist in distinguishing closely related taxa, interesting characteristics which help in distinguishing taxa, and special references to the plants as they occur in Michigan as compared to elsewhere in their ranges.

The value of this most useful book is not restricted to Michigan botanists and naturalists, but to those of the surrounding states as well. Not all the species found in Michigan will occur in those parts of Ontario which are adjacent to the state, but the majority of plants found there will be treated in this work, so that students in this part of Canada will find it a most welcome addition to their libraries.

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ZOOLOGY

Les Oiseaux du Québec

Par Raymond Cayouette et Jean-Luc Grondin. La Société zoologique de Québec, Inc., 8191 ave du Zoo, Orsainville, Québec. 1972. 117 pp. $3.00.

Depuis plusieurs mois déjà, cet ouvrage était attendu dans les milieux ornithologiques du Québec. Pour ma part, ce fut une agréable surprise que de voir pour la première fois ce volume de grandes dimensions (21,5 × 28,0 cm) agrémenté de deux excellentes planches en couleurs aux couvertures frontales et dorsales.

En feuilletant le livre, j'ai favorablement été impressionné par la qualité, la quantité et le style des illustrations. On y représente 243 espèces par des dessins au trait d'une remarquable exactitude. Ces dessins ont aussi le mérite d'être charmants et disposés d'une façon ravissante qui saurait plaire aux lecteurs les plus critiques. Un examen plus attentif révèle que la texture des dessins est de façon générale excellente quoique un peu dure, parfois même crue dans quelques cas, ce qui n'enlève rien à leur charme. À mon avis, les oiseaux les moins réussis sont les viréos, où les proportions ne sont pas justes. À quelques endroits, on remarque certaines difficultés anatomiques, comme chez le Junco ardoisé et le Bécasseau à poitrine cendrée en particulier. Malgré ces limitations mineures, facilement corrigibles, M. Grondin, l'auteur des dessins au trait et des planches en couleurs, doit être félicité d'un ouvrage d'une qualité si uniforme et d'un style aussi sûr. J'espère que cette première tentative l'encouragera à poursuivre une carrière si bien ébauchée.

La lecture du texte est facile et plaisante. M. Cayouette a su, dans un style à la fois agréable et bref, communiquer suffisamment d'informations concernant chacune des espèces représentées dans le volume pour servir de référence de base aux débutants et aux amateurs. Je me dois ici de souligner que le titre de l'ouvrage eut été plus approprié s'il avait été «Oiseaux du Québec» puisqu'on y décrit moins des deux tiers des espèces qui ont jusqu'à maintenant été homologuées dans la province.

Le volume contient une table des matières qui s'avère très utile et un avant-propos qui fournit des détails ayant trait à l'ornithologie et à l'observation des oiseaux, ainsi qu'aux instruments nécessaires à l'identification sur le terrain. Suivent cent pages de texte où les espèces sont groupées parfois par ordre, parfois par famille, parfois arbitrairement. Il semble qu'on n'ait pas voulu adopter l'ordre phylogénitique au sens strict ni se limiter aux groupements reconnus. La seule réserve que je formule sous ce rapport tient au fait que les groupements adoptés sont quelquefois aléatoires; cependant, ceci n'enlève rien à la valeur de l'ouvrage. On a consacré les sept dernières pages à un index général, à un index des noms anglais et à la toute fin à un index des noms vernaculaires. Ce dernier contient la majorité des appellations familières et locales dont on affuble les oiseaux dans certaines régions du Québec, même par toute la province, faute d'en connaître le nom véritable. Heureusement, certaines de ces appellations sont pittoresques et hautes en couleur. Cette partie devrait s'avérer très utile aux amateurs peu familiers avec les noms français reconnus que les auteurs ont utilisés, M. Cayouette étant membre du Comité permanent des Noms français des Oiseaux du Canada.

J'ai trouvé la lecture du texte agréable et l'information juste. On fournit une introduction générale avec chaque groupe en donnant une brève description de certains caractères anatomiques ou en présentant des observations sur son histoire naturelle. La longueur totale et l'envergure de chaque espèce apparaissent aux légendes des dessins.

J'ai noté quelques imprécisions dans le texte, les plus sérieuses étant les suivantes: l'*Oie bleue* n'est pas une mutation de la *Petite Oie blanche,* mais un morphe ou une phase de coloration de l'Oie blanche. Il eut ainsi été préférable de grouper ces deux formes sous un seul vocable: l'Oie blanche. Je crois qu'on aurait dû mentionner que le Faucon pèlerin est disparu comme nicheur dans le sud du Québec. Les sourcils charnus rouge vif du Tétras des savanes ne se gonflent pas d'air, mais augmentent de volume sous l'effet d'un apport sanguin. Les "sons étranges produits" par la Gélinotte huppée résultent de la compression et de l'expulsion rapide de l'air entre les ailes et les flancs de l'oiseau et non du battement des ailes contre les flancs. Il semble aussi que la Sterne noire n'a pas récemment envahi le sud du Québec, mais qu'elle s'y trouvait depuis longtemps. L'Étourneau sansonnet a fait son apparition au Québec à Betchouane en 1917. On remarque aussi quelques inexactitudes dans l'aire de répartition de quelques espèces. J'ai noté moins de 20 erreurs typographiques, ce qui démontre le soin apporté à la préparation de l'ouvrage.

La présentation est bonne et la mise en page soignée. Je crains cependant que la couverture et la reliure ne résistent pas à un usage soutenu. Le prix de vente, bien inférieur à ce qu'on s'attendrait de payer pour un livre du genre, rend cet ouvrage accessible à tous.

Malgré mes remarques critiques, on doit féliciter les auteurs du souci de perfection qu'ils ont démontré sous tous les rapports. Je suis convaincu que tous ceux qui liront ce livre passeront des heures agréables et c'est sans réserve que je le recommande à ceux qui s'intéressent à l'histoire naturelle, spécialement aux oiseaux.

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The Eastern Panther

By Bruce S .Wright. Clarke, Irwin and Company Ltd., Toronto. 1972. 180 pp. $6.50.

The Eastern Panther — a question of survival (as the book is subtitled) — provides proof positive that the cougar lives yet in the maritimes and eastern parts of Canada. The corroborative proofs lacking are photographs and live or dead specimens.

The book is divided into seven chapters with two appendices. The chapters are these: In the Beginning; The Panther of Eastern Canada; Recent Reports from the Eastern United States; The Animal; Methods of Field Study; Some Sighting Sequences and Their Interpretations; The Future — Status and Research Needs. The two appendices are selected reports from eastern Canada and the eastern United States.

The evidence establishing that the cougar is living in eastern Canada, but probably in very low numbers, is provided mainly through numerous sightings of the cougar over many years, foot prints in mud and snow, occasional kills that have been found, and a few old photographs. In spite of the mountain of evidence provided by Mr. Wright, there are still some who remain dubious because the cougar was "not seen in the flesh by a scientist." Mr. Wright, and another person with him, are among those who have seen the cougar alive in the wild state in New Brunswick.

The author has taken license to recreate the probable course of events leading up to a cougar sighting, and again, those after the sighting. Although these re-creations are pleasing to read, they detract from the scientific credibility of the book, and to many scientists will seem fanciful. My own opinion is that, unless the author examined the place of the cougar sighting personally, he has over-extended himself.

The main advantage of publishing the information on the eastern cougar in Canada in a book, rather than as an article in a journal, is that the information may reach the non-scientific public. If, as a result, one photograph is caused to be taken to prove the existence of the eastern cougar by an otherwise unconcerned person, then the book will have completed its purpose.

The book is well bound in buckram. The printing is clear and easy to read and free of typographical errors. The references listed are complete, with the earliest listing being 1705. Most of the index is composed of persons who have made cougar sightings. I recommend the book for a couple of evenings' pleasant reading.

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History of the Birds of Kingston, Ontario

By Helen R. Quilliam. Kingston Field Naturalists, P.O. Box 231, Kingston, Ont. 1973. 2nd Ed., revised. 209 pp. $4.95.

The privately printed first edition (1965) of this book was sold out within two years. The continuing local and provincial demand for one of the most comprehensive studies of a local bird fauna in Ontario has now led to its republication. Changes in status of several species were believed to warrant a thoroughly revised edition.

A few species of colonial water birds show marked decreases, possibly in response to environmental contamination by toxic chemicals. Documentation of these changes is perhaps the greatest value in the revisions. Unfortunately, a typographical error in data supplied to the author suggested a much greater decline in Common Terns than was actually the case.

Mean arrival and departure dates have been recalculated throughout. However, most of these made no real difference to the seasonal status. Many records of species not previously recorded or found breeding in the area are included, as well as new early or late dates and high counts. These often resulted from the increased numbers of observers, their greatly increased mobility, and the inclusion of the New York State and Prince Edward County parts of the 30-mile diameter circle. The latter areas might well have been excluded in the interests of ecological and geographical unity, as well as for better comparison with former years.

Most numerical comparisons between years and species were based, in the new edition, on data from the roadside breeding bird surveys. These involve a carefully standardized method of collecting data. However, changes in the six or seven local samples seldom have statistical significance, and most are probably only chance fluctuations. Most comparisons of numbers between different species are of questionable value because of differences in detectabiilty (i.e. in size, color, or song) of these birds. Such comparisons should be accepted only with great caution.

The offset printing method used does not allow a second chance for detecting errors, whether typographical or otherwise. Unfortunately, many errors escaped the proof-reading, though few if any seriously affect the overall accounts.

In summary, I believe that most changes made might more simply have been included as an appendix, or omitted. But the *Birds of Kingston* will continue to be a valuable reference, now available to a wider audience as a result of its reprinting.

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Buffleheads

By Anthony J. Erskine. Canadian Wildlife Service Monograph Series Number 4. Information Canada Catalogue No. R65-7/4. 1972. 240 pp. $7.50.

Each year the Wildlife Society selects a publication on fisheries and one on terrestrial wildlife for an award in recognition of excellence. The 1972 terrestrial award was made to Dr. Leslie M. Tuck for his book on the *Snipes,* but the awards committee decided to recognize Dr. Anthony J. Erskine's book on *Buffleheads* with an honorable mention. This recognition is well deserved and *Bunffleheads* should find a place on the shelves of naturalists, hunters, and scientists alike.

Dr. Erskine's field studies on Buffleheads have spanned a period of nine years, and have taken him across the continent to the wintering grounds on both the Pacific and Atlantic coasts. He has followed the birds along their migration routes and has studied their breeding biology in British Columbia and Alberta. His data are presented in a readable style pleasantly free from jargon and the stilted English which so often spoil a scientific work.

Until the release of this monograph, the only information on Buffleheads was scattered in a large number of publications. Dr. Erskine has done a thorough job of reviewing the literature and includes 210 references in his bibliography. The book is organized into 15 chapters which deal with most aspects of the life history of the species. As a book of reference I missed an index, but the table of contents and the clear organization of the text partially compensate for this omission.

The lack of knowledge about Bufflehead biology in Ontario and Quebec is apparent from Dr. Erskine's account. He suggests that the species breeds in light densities across much of central Ontario and part of Quebec. I have often wondered about the Bufflehead's true status since this bird is a common migrant through Ontario in spring and fall and is noted regularly in central Ontario in summer. Although there are very few substantiated breeding records for Ontario, Indians have told me of breeding Buffleheads from eight different Band Areas in northwestern Ontario. The Indians know the species well and call it Kawmayakashish. Avoiding pike-infested waters, breeding birds are probably hard to find on the small ponds that lie off the usually travelled canoe routes.

It will be up to naturalists and sportsmen to fill in this and other gaps that remain in our knowlege of Buffleheads.

The book seems to be relatively free of misprints, with the exception of the captions beneath the band recovery maps. A correction sheet is provided. At $7.50 *Buffleheads* is modestly priced by present standards. The high quality of its contents makes it well worth the cost.

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ENVIRONMENT

Canadian Parks in Perspective

By J. G. Nelson (editor). Harvest House, Montreal. 1970. 343 pp. $3.50 paper, $5.95 cloth.

This book, which says little about national parks which we haven't heard before, is nevertheless welcome in that it is nice to have what it does say all in one place. It consists of 20 papers, chosen from 40 given at the 1968 Calgary conference "Canadian National Parks Today and Tomorrow." Selecting "to emphasize a Canadian theme" and to "include . . . as many topics as possible," Dr. Nelson has done a good job in this respect as, indeed, he has done with the rest of his editorial work; typographical errors are few and minor. My paperback copy, in 8" x 5½" format, is well-bound and well-printed, a sturdy little book that promises to survive a lot more of the thumbing I have planned for it.

The variety of subjects which have been covered are organized into six major sections: (1) The Long View, (2) The Uses of Parks, (3) The Townsite in the Park, (4) Many Kinds of Parks, (5) What We May Learn From the U.S.A., and (6) Parks for the Future. In a short review such as this, I can extract only a few selective impressions from such diverse material, and I confess that these will be reflective more of my own prejudices than of especially meritorious points in the book.

It is clear that the present "facilities orientation" of Canadian parks has roots which go deep. The first park, Banff, was established not for protection of its natural features, but for *development* of its mineral springs. In time the "preservation-in-an-unimpaired-state-for-future-generations" concept appeared, at least on paper, but we have never stopped stubbing our toes on the facilities question. "Recreation," which can involve such inocuous (and pleasant) activities as lying back on a mat of mountain heather and watching a soaring eagle, more often these days involves activities which require "recreational facilities." While we have an obligation to provide for the complete spectrum of outdoor recreational "needs," we should look outside national park boundaries to provide for those which compromise park values. We need, *now*, to impress upon people that national parks are different. Meanwhile, though municipal type services in parks continue to consume a lot of the administrative attention and resources which natural features should be getting, events such as the recent Lake Louise decision suggest that Canadian national park philosophy is maturing.

Experience south of the border gives us a source of hindsight which we would do well to make use of. As is generally still the case in Canada, "wilderness" was once thought of in the U.S. as land for which no one had yet thought of a use, but, like other commodities, it became more valuable as it became rarer. It has now acquired a positive value well-recognized even in government circles. This fact is increasingly reflected in U.S. national park and national forest management plans; the national Wilderness Preservation System there, resulting largely from the work of citizen groups, has given a depth to wildland protection which we are far from attaining. Hopefully many of the readers of the book under review will be moved to support our own pertinent citizen groups such as the National and Provincial Parks Association of Canada.

That brings me to a final point. Who *will* be the readers of this book? Nelson says he has aimed it at "citizens and decision-makers." I am suspicious that few of these (who have not been converted previously) will be reached. The book is informative and useful, but it is not particularly entertaining and it is not attractive. Unfortunately, this will limit its effectiveness. In my opinion, a few photographs (including some in color) of Canadian Park magnificence inserted between chapters would give the book some initial attractiveness, would help break the monotony which inevitably accompanies symposia, and would help the reader keep in mind that the subject at hand is much more than just words and ideas.

I suggest, then, that with *Canadian Parks in Perspective*, the job has just begun. The facts and ideas relative to parks in Canada (there are over 30 pages of bibliography in addition to the 20 essays) are easier to get at than ever before. The task remaining is for the already-faithful to gather and glean the really important points to be found here and to dress them up for more popular presentation. A good theme could quite properly be based on Aldo Leopold's profound observation that "recreational development is a job not of building roads into lovely country, but of building receptivity into the still unlovely human mind."

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The Hazardousnous of a Place. A Regional Ecology of Damaging Events

By Kenneth Hewitt and Ian Burton. University of Toronto Press, Toronto. University of Toronto Dept. Geography Research Publication No. 6. 1971. 154 pp. $5.00.

The reactions of individual humans to natural or man-made disasters provide the theme for much of the world's great literature. Ecology, the study of the interactions of living organisms with their environment, is a fascinating and currently popular subject. However, those things are not what the book is all about.

The author documents the nature and frequency of occurrence of disasters and discusses their severity and the institutionalized responses of society. The major acknowledgment is of "the generous support of the Canada Emergency Measures Organization."

The second chapter opens with the statement "The central interest of this study is in the complex of conditions which define the hazardous part of a region's environment." That, of course, is just one more example of misuse of the word "environment;" which means, briefly, "that which surrounds." Yet, the authors stress occurrences within a region.

The third chapter is entitled "Natural hazards in the London Region of Southwestern Ontario." That title, expanded to include man-made hazards, could have been used for the whole publication.

The hazards discussed are mostly those of abnormal, or unusually intensive weather or climatic phenomena, and of disasters arising from human error — mainly industrial and transportation accidents, and fire.

Southwestern Ontario was the study area, but comparative data, applicable to many parts of North America, were also collected. Most of those data are presented in 42 tables and 24 illustrations which are generally well presented and easily comprehended. The text tends to be jargonistic and multisyllabic. There is a bibliography of about a hundred titles.

A reviewer usually stops when he reaches the bibliography. However, remembering the story of the blind man who could describe only that part of the elephant within his reach, I wanted to step back and obtain a photograph to show the prospective reader the shape of the whole animal. The only glimpse of the broad picture I obtained from the book was afforded by an acknowledgment: "The study was also helped in manpower and ideas by association with the closely related research on natural hazards supported by the U.S. Natural Science Foundation at the University of Colorado, Clark University, and the University of Toronto." I am indebted to Professor W. R. D. Sewell of the University of Victoria for alerting me to the existence of a progress report dated August, 1971. The main collaborators are Robert W. Kates of the Graduate School of Geography of Clark University, Gilbert F. White of the Institute of Behavioral Science, University of Colorado, and Ian Burton of the Environmental Sciences and Engineering Programme, University of Toronto.

The report contains a list of 20 working papers, 10 journal articles, four books and monographs (including the book under review), seven completed dissertations and theses, and three in progress.

Two paragraphs, taken from pages 1 and 18 of the report, provide background and fill in details.

"The collaborative program of natural hazard research aims to understand the ways in which man perceives extreme natural events and adjusts to the hazard; to apply this knowledge towards reducing the social cost of these events; and to extend such understandings to the complex of largely man-made environmental risks. The program, which began formally in September 1967, with support from the National Science Foundation, followed a decade of geographic research into the human ecology of extreme geophysical events, and now aims at drawing together findings from a wide variety of studies in late 1972."

"Finally, we will draw together the results of the five-year research program in a form suitable for publication as a short book by the three principal investigators. This may be expected to provide a culmination to the program by setting forth the state of knowledge achieved by that time on natural hazards, and by developing to some extent the implications of the research for environmental hazards of all kinds."

If natural hazards research is your special interest you will want a copy of this book. If your interests are more general, you may decide to wait and watch for the more comprehensive (and hopefully, better written) publication which is promised.

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Readings in Aquatic Ecology

By Richard F. Ford and William E. Hazen (Eds.). W. B. Saunders Co., Philadelphia and Toronto, 397 pp. 1972. $6.95 paper.

This book is a collection of 29 previously published scientific papers concerning various topics in freshwater and marine ecology.

There is often a real need for books of this form in intermediate- or senior-level university courses, where the inadequacies of textbooks may become unacceptable, and a satisfactory degree of student consultation of original articles in academic journals may be logistically impossible. The form is less important, however, in the final analysis, than the wisdom employed by the editor(s) in judging the needs of the students and in selecting papers to meet those needs.

This collection includes many excellent papers, but in my view it will have little appeal to most of its potential readers. Its major fault is that it lacks a prominent and meaningful central theme. Thus it has about as little value, as a collection, as any volume of a similarly oriented scientific journal. There are similarities that tend to unite many of the papers, and that could have contributed to a theme, but these have been largely obscured by the categories into which the papers have been placed.

The editors' Introduction is almost entirely devoted to convincing the reader that marine and freshwater ecology are one discipline. The opening sentence reads, "We approach the subject of aquatic ecology with the conviction that a large body of data and theories, problems and practices are common to both the ocean and to inland bodies of water." Possibly the justification of that sweeping assertion was intended to be a central theme, but if so, it is not evident in either the content of the papers or the way in which they were grouped. It appears, rather, that this "conviction" was put forward as a justification for pretending that there are no real differences between the ecology of freshwater and marine ecosystems. Surely the organisms are different, and surely ecology is a biological science. There can be no doubt that a great many problems and practices and some general ecological theories are common to oceanography and limnology, but the claim that data are also in common is considerably less than a generally acceptable opinion. One is left with the feeling that the editors were somewhat overzealous in their attempt to appeal to all aquatic ecologists, and allowed themselves to be less than completely objective in their overview.

The group to whom the book will be of most value will be students of marine ecology who have a particular interest in the plankton community. Only seven of the papers included deal specifically with freshwater habitats, and approximately half of the papers deal with the plankton. Research at the community and ecosystem levels is also emphasized, and valuable experimental techniques are described in about half of the articles. A 2-page index has been included.

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The Violated Vision

By James Woodford. McClelland and Stewart Ltd., Toronto. 1972. 136 pp .$5.95.

The subtitle of this book, "The Rape of Canada's North," informs the reader immediately of Mr. Woodford's attitude — that the past and present commercial activity in the Arctic, mainly by oil companies, is "wrecking the joint." Further, he maintains that if the Canadian Government allows the present kind and rate of virtually unchecked surface destruction to continue, the Canadian Arctic is lost. He states that it is not too late to save it if we recognize that in the Arctic it is man, not nature, that must be managed.

The book has nine chapters interestingly titled as follows: Damn the Ecology — Full Speed Ahead; The Tundra World; The Importance of the Arctic to Science; Polar Pollution; Tomorrow's Wilderness; Who Owns the Beautiful Land?; The Trudeau Doctrine; Stop the Elephant Hunt; If the Environment is the Vision.

Although the purpose of the message Mr. Woodford has written is understood, I do not think that he has organized the message clearly. I find the book more or less a continuous tirade of an angry man against the Government's Policy, with a few constructive suggestions for altering the Policy given in the last chapter. The book might have been better organized with a develop-

mental progression of a statement of the problem, history of the problem, documentation of present policy of the Government and operational methods of the commercial companies, and then constructive suggestions for new policy and Governmental reorganization.

Mr. Woodford makes a few statements that sound very knowledgeable, but which are either wrong or meaningless. For example:

1. The second sentence of the Introduction reads, "Low temperatures, sparse soils and other factors have created ecological systems unlike any other on earth." Ecological, or biological, systems are the same throughout the world — only the plant and animal groups, and the degree of complexity vary.
2. Page 31: "For most of the year it [the Arctic] is strikingly inhospitable to life . . . most of the animals take temporary leave." In fact, however, birds are the only animals which take leave. All the mammals and invertebrates remain in the Arctic.
3. On page 40, he wrote that there are 9600 species of birds and 3200 species of mammals in the world. My information reads 8600 and 5600 species, respectively.
4. On page 122 he wrote, "The basic task of ecology is not to tinker with technology . . . ." "Ecology" cannot have a task, as it is a discipline or study of one or more organisms in relation to their environment and to each other. Mr. Woodford does not use the word "ecology" correctly throughout most of the text.

There are a number of small errors that could be the result of either carelessness or typographical misprint: page 76, for Dezabeash, read Dezadeash; page 79, for John I. Nichol, read John I. Nicol; page 79, Kluane National Park, for 10,120 acres, read 10,120 square miles.

I find annoying the habitual change of a person's title from a "noted Canadian" to "Professor" to "Dr" to "ecologist" and so on, to suit the occasion (cf. Dr. W. A. Fuller and Dr. Maurice Strong on many pages). The author uses alliteration interestingly (e.g., "violated vision," "tinker with technology," "ecology . . . over . . . economics"). One of them stumped me — "brumal barrens" (page 99). I had to consult four dictionaries before I found that "brumal" means "of winter or frosty."

The book is well bound in an imitation buckram. The print is clear and of a size pleasant for evening reading. The cover photograph on the front jacket is well chosen — a polar bear in a garbage dump. I found the book an enjoyable three hours' reading.

ROBIN LEECH

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In Quest of Quiet

By Henry Still. Stackpole Books, Harrisburg, Pa. 1970. 221 pp. $6.95.

The detrimental effects of air, water, and soil pollution, which have been steadily invading our society over the years until they have reached almost insurmountable proportions, have become reasonably well documented. Less well documented, however, has been the serious consequences of the insidious advance of another form of air pollution in our daily lives (and an obnoxious invasion of our privacy) — that of noise.

Now, at last, competent writers are beginning to document, and take issue with, *this* aspect of environmental pollution. Henry Still is one and his book goes a long way towards, as he indicates in the preface of the book, "identifying the main sources in the rising tide of sound which threatens to engulf us" and "suggest(ing) some ways in which we may move forward to a quieter world." From the opening chapter, where examples of noise associated with contemporary living establishments are shown to abound, through the chapters on musical sounds, freeway and general traffic noise, industrial and community noise, and aircraft noise (including supersonic transports) to the closing chapters on the physical aspect of sound and the physiological and psychological damage associated with noise, there is ample evidence that this type of "food for thought" should be considered as recommended reading for all conscientious citizens in this 20th century. Moreover, it should be required reading for those who are in any way associated with the design of, and specifications for, machines, buildings and structures, manufacturing plants, or transportation systems. This applies equally to those who are or may be involved in urban and regional development or in the establishment of legislation

(be it at the municipal, state, or federal level) pertaining to the prevention and control of noise pollution.

On reading this book, one is immediately impressed with the wideranging scope with which the writer has tackled the subject. The historical references, the documentation of contemporary developments and situations concerning noise pollution, governmental activity (or the lack of it, as the case may be), and the integration of these with a relatively sound understanding of technical know-how have contributed, in my opinion, to a book that is both factually sound and readable to a relatively wide spectrum of readers. In fact, Mr. Still has brought together a wealth of general knowledge on the subject (and which, while catering primarily to the generalist, should prove to be welcome reading for specialist groups also); this asset is further emphasized by the inclusion of a very comprehensive list of references for each chapter in the book.

On the negative side, I think he could have placed more emphasis on the noise abatement studies and programs which *have* been initiated, both in the United States and in other countries; some of these studies, and in particular the procedures employed for controlling noise in other countries, seem to be well advanced. Further, as an educator, and one who advocates in his students an understanding of the "why" as well as the "what," my own preference would have been to have interwoven, if possible, Chapters 11, 12, and 13 of Section IV (i.e. those chapters on the dimensions of sound, physical harm, and mental friction) throughout the earlier chapters of the book — or, perhaps, to have introduced them at an earlier stage. Notwithstanding the fact that the author probably had in mind that he didn't want to confuse the reader (who may be a neophyte to noise) with technical terminology and facts, I do believe that the impact of the message that he wishes to convey in many of the chapters would have had greater effect had the reader been given some of this semi-technical background information earlier. (It must be conceded, though, that the author has given the reader the opportunity to delve into the technical aspects of sound by reference, in the introduction, to the appropriate chapter(s) at the end of the book.)

Lastly, on the negative, there are one or two areas in which Mr. Still's technical explanations are not quite correct — as, for example, when reference is made to db loss through certain barrier materials such as doors; to be rigorous, this db loss should be identified in certain frequency bands or, as a single number, should be referred to as a sound transmission class STC (which is an "average" of the losses in the various frequency bands and conforms to preferred contours which have been established for sound transmission loss). However, by and large, these minor inaccuracies are few, and the author can be commended for his relatively rigorous adherence to technical fact.

I intend to recommend this text as preferred reading to students in my classes in mechanical design, and engineering and architectural acoustics.

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London, Ontario, Canada

OTHER BOOKS

Wilderness Writers

By James Polk. Clarke, Irwin and Company Ltd., Toronto/Vancouver. 1972. 147 pp. $3.50.

From the dust jacket: *"The Canadian Portraits* series is designed to encourage interest in Canadians who have led interesting lives and made a contribution to the development of this nation."

Only three writers qualify: Ernest Thompson Seton (1860–1946), Sir Charles G. D. Roberts (1860–1943), and Grey Owl (born Archibald Standsfield Belaney) (1888–1938).

Seton's life history reads as though the biographer had finished all four volumes of "Lives of Game Animals" at one sitting, and, without sleeping off the intoxication, had written the life of a game man: from a sickly and unhappy childhood to a happy and healthy old age; 86 years in 45 pages.

Sir Charles G. D. Roberts, though a contemporary of Seton's, reversed his life pattern: a childhood so idyllic that nothing in later life seemed to improve on it, neither success, material prosperity, or fame.

Seton and Roberts get sympathetic treatment. For Grey Owl, sympathy is larded with sentiment.

The first 15 of 45 pages deal with his English beginnings. The stilted dialogue attributed to his mother and his aunts portrays the presently accepted version of that childhood. His lifelong habit of deserting wives and daughters is recorded without recrimination. He is idealized as — what else? — an idealist.

It is an unpretentious little book, aimed at a young audience. Original sources are named. Photographs and illustrations are well chosen to complement the text. At $3.50 it is good value for interested readers of any age.

D. A. BENSON

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Ottawa, Canada K1A 0H3

NEW TITLES

Zoology

Armstrong, D. M. 1973. **Distribution of Mammals in Colorado.** Museum of Natural History, University of Kansas. 415 p. $16.00.

Anderson, D. R., and C. J. Henny. 1973. **Population Ecology of the Mallard: I. A Review of Previous Studies and the Distribution and Migration from Breeding Areas.** Resource Publication 105, Bureau of Sport Fisheries and Wildlife. 166 p. $1.50. Available U.S. Government Printing Office, Washington D.C.

Bick, H. 1972. **Ciliated Protozoa: An Illustrated Guide to the Species Used As Biological Indicators in Freshwater Biology.** World Health Organization, Geneva. 198 p. $6.00. Distributed by American Public Health Association, Washington D.C.

†Edelstam, Carl. 1972. **The Visible Migration of Birds at Ottenby, Sweden.** Var Fagelvard, Suppl. 7. (Ottenby Bird Station Report No. 58). 360 p. 95 Sw. cr. payable to Sveriges Ornitologiska Forening, Runebergsgaten 8, S-114 29 Stockholm.

Ernst, C. H., and R. W. Barbour. 1972 **Turtles of the United States.** The University Press of Kentucky, Lexington, Ky. 40506. $22.50.

*Ewer, R. F. 1973. **The Carnivores.** Cornell University Press, Ithaca, N.Y. 494 p. $21.50.

Farner, D. S. (Ed.). 1972. **Breeding Biology of Birds.** U.S. National Academy of Sciences, Washington D.C. 515 p. no price given. Proceedings of Symposium on Breeding Behaviour and Reproductive Biology in Birds. Available from NAS Printing and Publications Office, 2101 Constitution Ave. N.W., Washington D.C.

Gill, F. B. 1973. **Intra-Island Variation in the Mascarene White-eye *Zosperops borbonica*.** American Ornithologists Union Ornithological Monograph No. 12. 66 p. $2.00 ($1.60 to AOU members). Available from B. L. Munroe, Box 23447, Anchorage, Ky. 40223.

Harrison, R. J. (Ed.). 1972. **Functional Anatomy of Marine Mammals.** Academic Press Inc., New York. 452 p. $21.00.

Hartshorne, C. 1973. **Born to Sing: An Interpretation and World Survey of Bird Song.** Indiana University Press, Bloomington, Ind. 304 p. $10.00.

Irving, L. 1972. **Arctic Life of Birds and Mammals.** Springer-Verlag Inc., New York. 191 p. $14.00. Vol. 2 in series Zoophysiology and Ecology.

†Johnsgard, P. A. 1973. **Grouse and Quails of North America.** University of Nebraska Press, Lincoln, Ne. 553 p. $25.00.

Klauber, L. M. 1972. **Rattlesnakes: Their Habits, Life Histories and Influence on Mankind.** University of California Press, Berkeley. Vol. 1, pp. 1-740; Vol. 2, pp 741-1534. $50.00 set.

Llano, G. A. (Ed.). 1972. **Antarctic Terrestrial Biology.** American Geophysical Union, Washington, D.C. 322 p. $30.00.

Marshall, S. M., and A. P. Orr. 1972. **Biology of a Marine Copepod.** Springer-Verlag Inc., New York. 195 p. $12.10.

Menton, S. A. Jr., and M. Rutherford Menton. 1972. **Venomous Reptiles.** George Allen and Unwin Co., London. £3.95.

Richman, Gary. 1973. **Rhode Island Insects: An Insect Colouring Book.** University of Rhode Island and U.S. Dept. Agriculture Co-operative Extension Service, Kingston, R.I. 27 drawings, 25¢. A colouring book for children with good drawings and informative captions for each. Suffers from a lack of size indications and no details as to the colour of each insect.

*Tietz, H. M. 1972. **An Index to the Described Life Histories, Early Stages and Hosts of the Macrolepidoptera of the Continental United States and Canada.** Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, 90007. 2 vols., 1041 p. $25.00 set.

Environment

Allan, L., E. K. Kaufman, and J. Underwood *et al.* 1972. **Pollution in the Pulp and Paper Industry.** Published for the Council on Economic Priorities by M.I.T. Press, Cambridge, Mass. 506 p. $10.00.

Cicchetti, J. 1972. **Alaskan Oil: Alternative Routes and Markets.** Published for Resources for the Future Inc., Washington D.C. by Johns Hopkins University Press, Baltimore. 142 p. $5.00.

Curry-Lindahl, Kai. 1973. **Conservation for Survival.** Morrow Pub. Co., New York. $3.75.

Dasmann, R. E., J. P. Milton and P. H. Freeman. 1973. **Ecological Principles for Economic Development.** John Wiley and Sons Ltd., New York, 252 p.

Falk, Richard A. 1971. **This Endangered Planet: Prospects and Proposals for Human Survival.** Random House, New York. 498 p. $8.95.

Freeman, A. M., R. H. Haveman and A. V. Kneese. 1973. **The Economics of Environmental Policy.** John Wiley and Sons Ltd., New York. 184 p. $6.95 cloth, $3.95 paper.

†Goldman, C. R., J. McEvoy III, and P. J. Richerson. 1973. **Environmental Quality and Water Development.** W. H. Freeman and Co., San Francisco. 510 p. $17.50.

Hammond, A., W. Metz and T. Maugh II. 1973. **Energy and the Future.** American Association for the Advancement of Science, Washington D.C. $7.95 cloth, $3.95 paper.

Holdren, J. P., and P. R. Ehrlich. 1972. **Global Ecology: Readings Toward a Rational Strategy for Man.** Harcourt Brace Jovanovich Inc., New York. 295 p. $4.75.

Milne, Lorus and Margery Milne. 1971. **The Arena of Life: The Dynamics of Ecology.** Doubleday Co., New York. 352 p. $15.00.

Pollard, Jean Ann. 1973. **Polluted Paradise.** Twin City Press, Lewiston, Maine.

Potter, Jeffrey. 1973. **Disaster by Oil.** Macmillan Co., New York. 302 p. $7.95. Oil spills: Why they happen, what they do, and how they may be avoided.

Ricklefs, Robert E. 1973. **Ecology.** Chiron Press Inc., Box F. Newton Mass. special introductory price $9.00.

Stephenson, T. A., and Anne Stephenson. 1973. **Life Between Tidemarks on Rocky Shores.** W. H. Freeman Co., San Francisco. 425 p. $15.00 cloth, $6.95 paper.

Sumek, L. 1973. **Environmental Management and Politics: A Selected Bibliography.** Center for Governmental Studies, Northern Illinois University, DeKalb, Ill. 74 p. $2.00. Environmental Policy Series.

Thomas, W. A. 1972. **Indicators of Environmental Quality.** Plenum Publishing Corp., New York. 275 p. $18.50.

Watt, K. E. F. 1973. **Principles of Environmental Science.** McGraw-Hill, New York. 320 p. $10.95.

Zottoli, Robert. 1973. **Introduction to Marine Environments.** Thos. V. Mosby Co., Saint Louis, Mo. 125 p. $4.95.

Canadian

†Burnford, Sheila. 1973. **One Woman's Arctic.** McClelland and Stewart Ltd., Toronto. 222 p. $6.95.

†Doern, G. B. 1972. **Science and Politics in Canada.** McGill-Queen's University Press, Montreal. 238 p. $12.50.

Edmonds, Alan. 1973. **Voyage to the Edge of the World.** McClelland and Stewart Ltd., Toronto. 254 p. $10.00. In 1969-70, the Canadian Coast Guard ship Hudson circumnavigated the Americas. 122 scientists participated in the 59,956.5 mile journey and this is a highly readable account of the trip, their work, and them.

Environment Canada. 1972. **Conference on the Human Environment.** A report on Canada's preparation for and participation in the United Nations Conference on the Human Environment, Stockholm, Sweden, June, 1972. Available from Information Canada Bookstores, Halifax, Montreal, Ottawa, Toronto, Winnipeg, Vancouver. 71 p. $2.00. Cat. No. En 21-872.

Environment Canada. 1973. **The Environment Needs You.** Information Services, Dept. Environment, Ottawa, K1A 0H3. free.

Hemstock, C. A., and G. A. Cooke. 1973. **Yukon Bibliography Update 1963-1970.** Boreal Institute for Northern Studies, University of Alberta, Edmonton. Occasional Publication No. 8-1. 420 p. $10.00. Has author index and subject cross index.

†Jackson, J. N. 1973. **The Canadian City: Space, Form, Quality.** McGraw-Hill Ryerson Ltd., Toronto. 237 p. $6.50.

†Livingston, John A. 1973. **One Cosmic Instant: A Natural History of Human Arrogance.** McClelland and Stewart Ltd., Toronto. 243 p. $7.95.

Peck, George. 1973. **Ontario Nest Records Scheme; Ninth Report, 1972.** Royal Ontario Museum, Toronto. 22 p. no price given.

†Rowe, J. S. 1972. **Forest Regions of Canada.** Canadian Forestry Service Publication No. 1300. 172 p. $2.50. Available from Information Canada Bookstores. Cat. No. Fo47-1300.

†Rowland, Wade. 1973. **The Plot to Save the World.** Clarke, Irwin and Co., Ltd., Toronto. 194 p. $7.95. A guide to the 1972 Stockholm Conference on the

Human Environment, complete with the Declaration and all the Recommendations, as well as a guide to the Counter-Conferences.

Salt, W. Ray. 1973. **Alberta Vireos and Wood Warblers: Families Vireonidae and Parulidae; Distribution and Breeding.** Publication No. 3 of Provincial Museum and Archives of Alberta. Queen's Printer, Edmonton, Alta. 141 p. $4.50.

Soper, J. Dewey. 1973. **The Mammals of Waterton Lakes National Park, Alberta.** Canadian Wildlife Service Report Series No. 23. 55 p. $1.25. Available at Information Canada Bookstores. Cat. No. CW65-8/23.

Wiggins, G. B. 1973. **A Contribution to the Biology of Caddisflies (Trichoptera) in Temporary Pools.** Life Science Contribution No. 88, Royal Ontario Museum, Toronto. 28 p. $2.00.

Miscellaneous

Alaska Geographic Society. 1973. **Alaska Geographic.** Vol. 1 No. 1 of a new journal, the official publication of the Alaska Geographical Society. Available only to members of the Society. Box 4-EEE, Anchorage, Alaska 99509. A very attractive and colourful magazine. Titles of articles include The North Slope . . . Its Physiography, Flora and Fauna; Oil Around the Polar Rim . . . A Synopsis; Leffingwell . . . Pioneer Arctic Explorer-Scientist.

Anon. 1972. **Population Dynamics. Proceedings of a Symposium.** Academic Press Inc., New York. 446 p. $13.50. University of Wisconsin Mathematics Research Center Publication No. 29.

Brown, Lester R. 1972. **World Without Borders.** Random House, New York. 1972. 395 p. $8.95.

Evans, S. M., and J. M. Hardy. 1971. **Seashore and Sand Dunes.** Heineman Educational Books Ltd., London. 87 p. $2.00. Available in Canada from Bellhaven House, Scarborough, Ont.

Gabor, Dennis. 1972. **The Mature Society.** Prager, New York. 208 p. $7.50.

*Assigned for Review.

Gessaman, J. A. (Ed.). 1973. **Ecological Energetics of Homeotherms: A View Compatible With Ecosystems Modeling.** Utah State University Press, Logan, Utah. 155 p. $6.00.

Gorham, J. R. (Ed.). 1973. **Paraguay: Ecological Essays.** Academy of Arts and Sciences of the Americas, Miami, Fla. 296 p. $16.00.

†Hochachka, P. W., and G. N. Somero. 1973. **Strategies of Biochemical Adaptation.** W. B. Saunders Co., Philadelphia, London and Toronto. 358 p. $7.75.

†Merritt, Mabel Crawford. 1973. **Dance of the Mayflies and Other Nature Stories.** Exposition Press, Jericho, N.Y. 63 p. $3.50.

Ranwell, D. S. 1973. **Ecology of Salt Marshes and Sand Dunes.** Chapman and Hall, London. 528 p. $14.50.

†Rood, R. 1973. **Who Wakes the Groundhog: Early Risers and Late Bloomers in the Natural World.** W. W . Norton and Co., New York. 206 p. $7.95.

Savory, T. H. 1971. **Latin and Greek for Biologists.** Available from Bonn Industries Inc., Plainfield, N.J. 34 p. $4.00.

†Schopf, T. J. M. (Ed.). 1972. **Models in Paleobiology.** Freeman, Cooper and Co., San Francisco. 250 p. $9.40.

Taylor, S. A. (revised and edited by G. L. Ashcroft). **Physical Edaphology: The Physics of Irrigated and Non-irrigated Soils.** W. H. Freeman and Co., San Francisco. 533 p. $17.50.

Wagar, W. Warren. 1971. **Building the City of Man: Outlines of a World Civilization.** Grossman Pub. Co., New York. 180 p. $10.00.

†Reviewers are needed! Any person who is willing and qualified to review a book whether listed in this or previous New Titles lists, is invited to write the Book Review Editor, giving the name of the book and the author's name. Previous reviewing experience not necessary. Books marked † are currently available for review, but requests should not be limited to marked titles.

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Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

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The **CBE Style Manual,** third edition (1972), published for the Council of Biology Editors, Committee on Form and Style, by the American Institute of Biological Sciences, is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

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The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and co-operate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

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The Canadian Field-Naturalist

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Cover: Goshawk with prey (Ruffed Grouse) from a painting by Robert M. Bateman.

The Canadian Field-Naturalist

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Mailing date of previous issue November 2, 1973.

Let's Consider The Canadian Field-Naturalist

The Ottawa Field-Naturalists' Club has published a scientific journal since 1880. The history of this journal, The Canadian Field-Naturalist and its predecessors, has been well documented by W. J. Cody and B. Boivin (1954. Canadian Field-Naturalist 68: 127–132). They wrote, "From the very beginning the publication of a scientific journal was a major part of the activities of the Club and this emphasis may account for the continuity of publication . . .". In 1889 a report in the journal stated that "The scope of the publication has . . . been widened so as to include papers by members of the club upon the General Natural History of Canada". Since then it has grown and evolved; today The Canadian Field-Naturalist is an internationally recognized scientific journal. In 1970 the size and format of the journal were changed; its appearance was improved and a significant increase in the amount of material appearing in each volume was made possible. Beginning with the present volume, printing of the journal is by the photo-offset method with a resultant decrease in the cost of reproducing illustrations. I believe that in the future The Canadian Field-Naturalist should continue to cover a wide range of subjects and that it will continue to evolve.

The editorial policy set forth by Theodore Mosquin in 1970 (Canadian Field-Naturalist 84: 3) remains relatively unchanged. The strength of the journal lies in the types of manuscripts that are submitted and in the review of the manuscripts by competent referees. We must thank those who take on the scientific obligation of reviewing manuscripts and especially those few who do so promptly. The CBE Style Manual, third edition (1972) is strongly recommended as a guide to those preparing manuscripts and to those reviewing them. The appointment of a Copy Editor for the journal has eased the Editor's enormous and increasing work load and has ensured more consistency in the published papers. A recent addition to the journal's policy is for material that is not essential to the text of a published paper to be placed in the Depository of Unpublished Data at the National Science Library, National Research Council of Canada, Ottawa. Such material — extensive tabular material including long lists of species — can readily be retrieved by interested readers for a nominal charge.

The continued publication of The Canadian Field-Naturalist depends not only on acceptable manuscripts being submitted but also on sufficient funds being available to cover publication and distribution costs. Part of the recent publication expenses has been covered by grants from The National Research Council of Canada and The Canadian National Sportsmen's Show and we are indeed indebted to these organizations for their support. However, most of the publication costs are met by The Ottawa Field-Naturalists' Club. All fees collected from institutional subscribers and a proportion of the dues of Club members go to the journal. According to the present Club by-laws no individual can subscribe to the journal but one receives the publication by joining the Club. Two years ago the finances of The Canadian Field-Naturalist and The Ottawa Field-Naturalists' Club were considerably separated when it was decided to allot to the journal 40 per cent of all membership dues whether from members in the Ottawa area or those from elsewhere. A separate financial statement for The Canadian Field-Naturalist for the year ending November 30, 1972 was published in the first issue of this year (1973. Canadian Field-Naturalist 87: 103).

Lately the flow of manuscripts to the Editor has been increasing and we must concern ourselves with the future of The Canadian Field-Naturalist (scientific and financial) and with the relations between the journal and The Ottawa Field-Naturalists' Club in general. Is the allotment of 40 per cent of membership dues to The Canadian Field-Naturalist an adequate estimation of the overall interests of the

membership? Should we consider the possibility of having individual subscriptions to The Canadian Field-Naturalist (with all or most of the fees going directly to the journal) and/or should we consider having separate fee structures for Club members who wish to receive the Club's publications and those who do not? To determine the answers to these and other questions a questionnaire is being circulated on the Club's 1974 membership renewal form. All members are urged to complete this questionnaire. Additional comments by members as well as by non-member readers of the journal are welcomed.

LORRAINE C. SMITH
Editor

Notice

TO INDIVIDUAL AND FAMILY MEMBERS NOT RESIDENT IN THE OTTAWA AREA

Trail & Landscape is a non-technical publication of The Ottawa Field-Naturalists' Club. It includes articles on Ottawa-area natural history as well as Club news items. It will be sent to you at no cost if you request it in a letter to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada K1Y 4J5. *Librarians should note* that this does not apply to institutional subscribers.

Birds of the Kluane Game Sanctuary, Yukon Territory, and Adjacent Areas*

MANFRED HOEFS

Yukon Territorial Game Branch, Whitehorse, Yukon Territory

Hoefs, M. 1973. Birds of the Kluane Game Sanctuary, Yukon Territory, and adjacent areas. Canadian Field-Naturalist 87: 345-355.

Abstract. During the 1969–1972 period incidental notes were made on the birds observed during Dall sheep studies and other ecological investigations. A total of 147 bird species were recorded during this time; a total of 182 species has been reported by various investigators over the past 45 years. New breeding records were established for Red-winged Blackbird and American Redstart, and new sight records for Common Scoter, Osprey, Dunlin, Sanderling, Snowy Owl, Clark's Nutcracker, Starling, Audubon's Warbler, Palm Warbler, Northern Waterthrush, and Pine Grosbeak.

Introduction

Incidental notes were kept upon the birds observed in the Kluane Game Sanctuary, southwest Yukon Territory, during a Dall sheep study which extended from May 1969 to November 1971, with a short interruption during the winter of 1969–70. The study centered around Sheep Mountain, located at the Slims River Delta in the southwestern corner of Kluane Lake, and it was here where most bird sightings were recorded (see Figure 1). In 1972 the writer did an ecological investigation of the newly-proposed Kluane National Park on contract to the Canadian Wildlife Service. During this investigation bird records were supplemented by observations made in portions of the National Park not previously seen. The proposed National Park takes in about 85% of the Kluane Game Sanctuary.

Only a brief outline of the area is given here since several good descriptions are available in the literature. The Kluane Game Sanctuary is located in the southwestern corner of the Yukon Territory (Figure 2). Alaska, the 60th parallel, the White River, and the Alaska and Haines Highways form the boundaries. The size of the reserve is approximately 10,000 square miles. About two-thirds of it is composed of the glacier-clad St. Elias Mountains, which include the highest peaks in Canada; the remaining one-third is made up of the Duke Depression, Kluane Range, and Shakwak Valley (Bostock 1948). This third is the "zone of life." Within the Shakwak Valley, which runs in a northwesterly direction, are found the larger lakes — Kluane, Kathleen, and Dezadeash — and the Alaska and Haines Highways. Five large, glacier-fed rivers dissect the area: the White, Donjek, Duke, and Slims Rivers in the northern half of the reserve are part of the Yukon River Watershed, while the Alsek River which drains the southern half of the reserve, flows into the Pacific Ocean.

The Kluane area lies in the rain shadow of the St. Elias Mountains and the climate is semi-arid and continental. Annual precipitation is usually less than 10 inches. Summer temperatures hardly ever approach 80°F, and winter temperatures of —50° to —60°F are not unusual. Excellent reports on the geology, glaciology, and climate of the region are found in reports by Bushnell and Ragle (1969, 1970), Kindle (1953), and Muller (1967).

The Shakwak Valley is at an elevation of 2300 to 2600 feet. For the most part, it is covered by white spruce forest, which extends up the slopes to an elevation of 3500 to 4000 feet. The sub-alpine zone, composed mainly of dwarf birch and willow species, may go as high as 5000 feet. Dry, south-facing slopes in the forest as well as in the sub-alpine zone, are

*The newly-proposed Kluane National Park takes in about 85% of the area of the Kluane Game Sanctuary.

FIGURE 1. Airphoto with Sheep Mountain and the adjacent Mount Wallace in the center. The delta of the Slims River is in the foreground, Kluane Lake is on the right, and Sheep Creek with the adjacent Bullion Plateau is on the left. Photo (RCA T6-117R) is reproduced by permission of the National Air Photo Library, Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

usually occupied by grassland vegetation. The alpine zone, which is the most extensive vegetation type in the area, is dominated by mountain avens (*Dryas integrifolia, D. octopetala*) and several prostrate willow species (*Salix arctica, S. reticulata, S. polaris*). The upper limit of vascular vegetation is encountered between 7000 and 7600 feet. Permanent snow is found above the 8000- to 9000-foot level. Descriptions of the natural history of the region are given by Fisher (undated), Hoefs and Benjey (1971), Porsild (1966), Drury (1953), and Clarke (Biological reconnaissance of lands adjacent to the Alaska Highway in northern

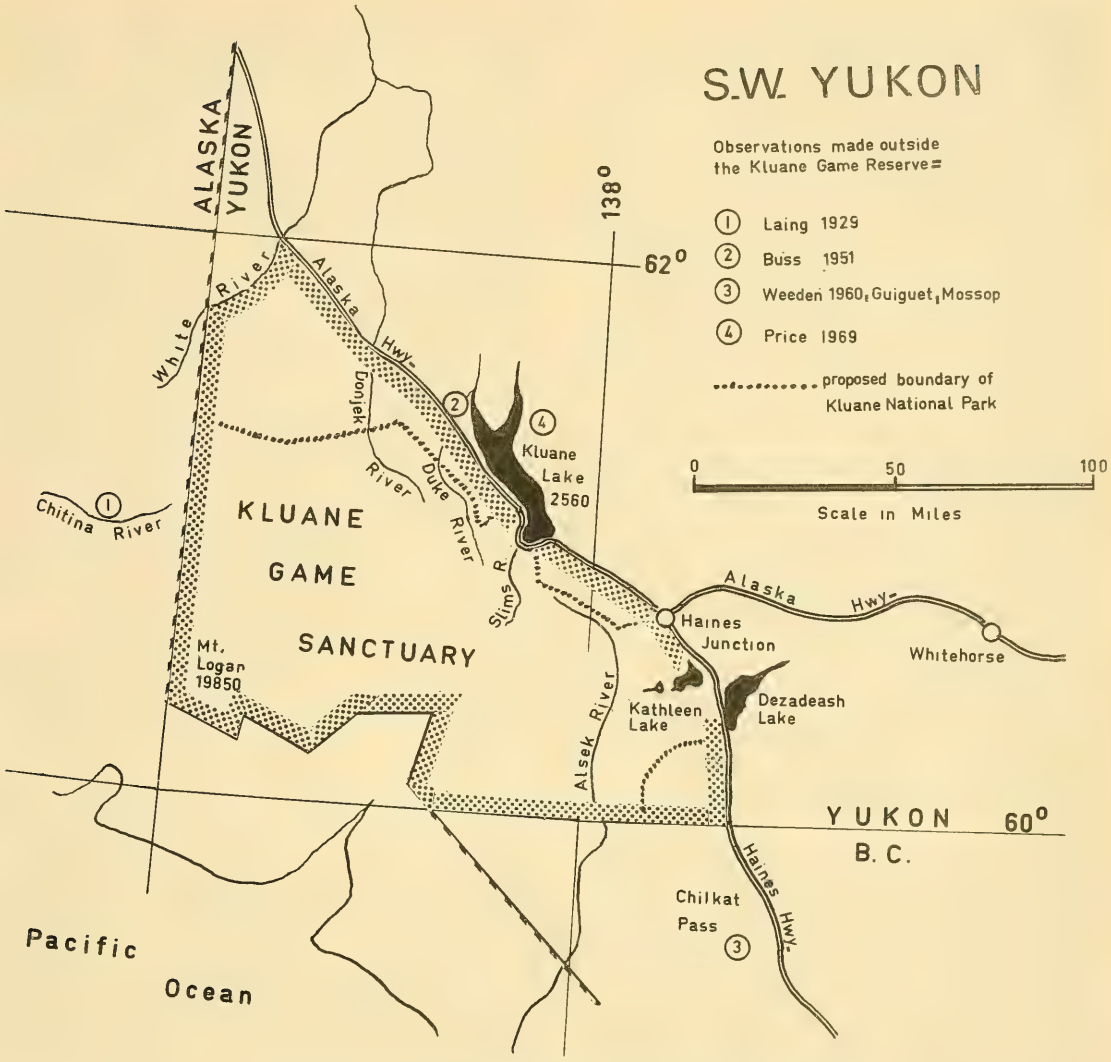

FIGURE 2. Kluane Game Sanctuary and adjacent areas.

British Columbia and the Yukon Territory. Unpublished report, on file with the Canadian Wildlife Service). Drury's (1953) paper is particularly interesting in this connection, since he relates bird distribution to vegetative cover.

Previous Ornithological Work

The following brief review lists previous ornithological investigations relevant to the Kluane area. To convey to the reader an impression of the total avifauna of the area, those species observed by previous investigators but not observed by the writer and associates during 1969 to 1972, are mentioned here.

Laing et al. (1929) reported the first bird observations relevant to the Kluane Reserve area. He accompanied members of the first Mount Logan expedition to the upper Chitina River in 1925 and made observations for a 3-month period that summer. The upper Chitina is located about 100 miles west of Kluane Lake, just across the Alaskan border (Figure 2).

Judged from the description given by the authors on physiography, climate, vegetation, and phenology, the upper Chitina must be very similar, ecologically, to the Kluane area. The list of Laing et al. for the upper Chitina of 75 species includes Swainson's Hawk.

With the opening up of the southwestern Yukon by the Alaska Highway in 1942–43, several important ornithological investigations followed in relatively short succession.

Clarke (1945; unpublished report) made a biological reconnaissance of the region for the Department of Mines and Resources in the summers of 1943 and 1944. He reported 106 species, including the following: Red-throated Loon, Pied-billed Grebe, Rufous Hummingbird, Eastern Kingbird, Traill's Flycatcher, Dusky Flycatcher, Common Crow, Mountain Chickadee, Brown Creeper, and Western Tanager.

Drury (1953) accompanied H. Raup and other investigators of Harvard University on a geo-botanical and archaeological expedition during the summer of 1948. He reported 107 species including the following: Red-necked Grebe, Ruddy Duck, Ring-necked Pheasant, Eastern Phoebe, Traill's Flycatcher, Solitary Vireo, Purple Finch, and White-throated Sparrow.

Godfrey (1951) visited the area for the National Museum of Canada in the summer of 1949. His report lists 95 species for the Kluane area, including Baird's Sandpiper, Traill's Flycatcher, Least Flycatcher, and MacGillivray's Warbler.

Soper (1954) did a waterfowl reconnaissance for the Canadian Wildlife Service during the summer of 1950 in the southern Yukon. Some of his observations are relevant to the Kluane region. He reported 74 species, including Redhead, Whooping Crane, Steller's Jay, Traill's Flycatcher, and Song Sparrow.

Stelfox (Annotated list of birds in the Yukon Territory 1950–55, with special reference to the Alsek Valley and St. Elias Mountains. Unpublished report, on file with the Canadian Wildlife Service) observed birds from 1950 to 1953 in the Kluane area while he was employed with the Canada Department of Agriculture Experimental Farm at Mile 1019 Alaska Highway. Stelfox's list of 97 species includes Barred Owl, Brown Thrasher, Brewer's Blackbird, Hoary Redpoll, American Goldfinch, Harris' Sparrow, White-throated Sparrow, Swamp Sparrow, and Song Sparrow.

The most recent "larger" investigation was done by Weeden (1960). He observed birds on the Chilkat Pass area in northwestern British Columbia, just south of the Kluane Game Reserve (Figure 2), during the summers of 1957 to 1959, while he was engaged in a ptarmigan study. Weeden reported 82 species, including Red-throated Loon, Western Sandpiper, and Hudsonian Godwit.

Besides these major reports several short papers are of importance to the ornithology of the Kluane area.

Buss (1951) did an ecological study of the Upland Plover population in the "Duke Meadow," which had previously been located by Clarke (unpublished report).

Banfield (1953) took incidental notes on birds while he was engaged in an investigation on large game mammals and fur bearers in the Kluane Reserve.

Guiguet (unpublished field notes) recorded birds along the Haines Highway, northwestern British Columbia, for the British Columbia Provincial Museum and the University of British Columbia in July 1956. His observations from the Chilkat Pass are relevant to the Kluane area.

Crook (unpublished field notes, on file with the Icefield Ranges Research Project camp of the Arctic Institute of North America at Kluane Lake, southwestern Yukon) observed birds in the Kluane Lake area during the summers of 1966 and 1967. Crook observed 65 species, of which the California Gull and Townsend's Warbler are significant, since no other investigator saw them.

Price (1969) found a breeding colony of the Long-tailed Jaeger in the Ruby range, near the Gladstone Lakes (Figure 2). This species was previously known to breed only in the Arctic, more than 600 miles farther north.

The most recently published bird observations were made by Tasker (undated report), who accompanied members of the centennial

climb "Expedition Yukon" to the Steele Glacier. His important contribution was to locate a breeding population of Snow Buntings, which were previously thought to breed only in the Arctic tundra.

Mossop (personal communication) was studying Willow Ptarmigan on the Chilkat Pass, south of Kluane National Park with the University of British Columbia from 1970 to 1973. Mossop's species list includes Red-necked Grebe and Rufous Hummingbird.

Theberge (field notes and personal communication) took incidental notes on birds in the Kluane Game Reserve while he was engaged in contract work with the Canadian Wildlife Service during the summer of 1972. His list of 92 species includes the Eastern Phoebe.

In 1968 Donald A. Smith (*Fide* W. E. Godfrey) observed a Lincoln's Sparrow nest near Christmas Creek, Mile 1048 Alaska Highway. Several investigators have seen this bird occasionally, but breeding had not been documented within the Kluane Game Sanctuary.

During the 1972 contract work the writer was ably assisted by Mr. Ken Summers of Vancouver.

Annotated List of Species

During this 3½-year period a total of 147 species was recorded. A total of 182 species has been reported by various investigators over the past 45 years.

To save space, notes and dates are restricted to very rare birds and to new sight and breeding records. To convey to the reader an impression of relative abundance the following rating was used:

rare = only one or two observations during the four-season period 1969 to 1972,
occasional = up to 10 observations,
frequent = up to 50 observations,
common = up to 100 observations,
abundant = more than 100 observations,
+ = direct evidence of breeding (eggs, young, food-carrying adults),
(+) = indirect evidence of breeding (time and frequency of observations, behavior, and appearance of birds led the author to assume that breeding took place).

A serious attempt was made to avoid duplications, and observation here means observation of different individuals, particularly with regard to "rare" and "occasional" birds.

The sequence of species in the list, as well as vernacular and scientific names, follows Godfrey (1966).

COMMON LOON. *Gavia immer.* Frequent; +.

ARCTIC LOON. *Gavia arctica.* Occasional.

HORNED GREBE. *Podiceps auritus.* Occasional.

SWANS. Flocks of up to 50 birds were observed during spring migration in early May 1969–1972. Those close enough for identification were *Olor columbianus.* A single swan was observed on a lake in the Koidern River area on June 22, 1972. No positive identification was possible. Frank Sais, Destruction Bay, told me that he observed a pair of swans raising young on a small lake in the Donjek River area some years ago. These may have been Trumpeter Swans *Olor buccinator,* but no Yukon breeding records are known.

CANADA GOOSE. *Branta canadensis.* Frequent.

WHITE-FRONTED GOOSE. *Anser albifrons.* Six were seen during migration on May 6, 1971, in the Duke River Delta.

SNOW GOOSE. *Chen hyperborea.* Flocks of up to 100 birds were observed in early May 1970 and 1971 in the Slims River flats.

MALLARD. *Anas platyrhynchos.* Common; +.

PINTAIL. *Anas acuta.* Occasional.

GREEN-WINGED TEAL. *Anas carolinensis.* Common; +.

BLUE-WINGED TEAL. *Anas discors.* Several males and females were observed with Mallards and Green-winged Teal on a small lake in the Koidern River area on August 15, 1971.

AMERICAN WIDGEON. *Mareca americana.* Occasional.

SHOVELER. *Spatula clypeata.* Occasional.

CANVASBACK. *Aythya valisineria.* Four males were seen in a pool along the Alaska Highway (Mile 1058) on May 14, 1971. Four males and two females were observed for a period of one week in early May 1972 on a small pond along the Alaska Highway (Mile 1071).

GREATER SCAUP. *Aythya marila.* Frequent; +.

LESSER SCAUP. *Aythya affinis.* Occasional.

COMMON GOLDENEYE. *Bucephala clangula.* Rare.

BARROW'S GOLDENEYE. *Bucephala islandica.* Frequent; (+).

BUFFLEHEAD. *Bucephala albeola.* Occasional.

OLDSQUAW. *Clangula hyemalis.* Six were seen on Kluane Lake October 20, 1971. Two were seen by Ken Summers in early June 1972 on a small lake near Christmas Bay, at the southeast corner of Kuane Lake.

HARLEQUIN DUCK. *Histrionicus histrionicus.* Frequent; +.

WHITE-WINGED SCOTER. *Melanitta deglandi.* Frequent; +.

SURF SCOTER. *Melanitta perspicillata.* Occasional; +.

COMMON SCOTER. *Oidemia nigra.* Fifteen males mixed with 50 Surf Scoters on Kluane Lake on July 7, 1970.

COMMON MERGANSER. *Mergus merganser.* Frequent; +.

RED-BREASTED MERGANSER. *Mergus serrator.* Occasional; +.

GOSHAWK. *Accipiter gentilis.* Frequent; +.

SHARP-SHINNED HAWK. *Accipiter striatus.* Frequent; +.

RED-TAILED HAWK.* *Buteo jamaicensis.* Frequent; (+).

ROUGH-LEGGED HAWK. *Buteo lagopus.* Observed every year during spring migration in late April.

GOLDEN EAGLE. *Aquila chrysaetos.* Common; +.

BALD EAGLE. *Haliaeetus leucocephalus.* Occasional; +.

MARSH HAWK. *Circus cyaneus.* Occasional; +.

OSPREY. *Pandion haliaetus.* One was observed on June 21 and 22, 1972, in the Koidern River area. The bird observed on June 21 was carrying a fish; this may indicate that it was feeding young. There is no previous record of Ospreys in the Kluane area. Mossop (field notes filed with Universtiy of British Columbia; personal communication) saw an Osprey around Kathleen Lake during the summer of 1972.

GYRFALCON. *Falco rusticolus.* This falcon was observed occasionally during fall and early winter, particularly on the Chilkat Pass area along the Haines Highway. A single bird was observed by Ken Summers at Cultus Bay, southwest corner of Kluane Lake, on June 8, 1972. This falcon was carrying a ground squirrel and was being chased by a Sparrow Hawk. Theberge (personal communication) saw a Gyrfalcon attacking a Golden Eagle on June 19, 1972, in the Slims River Valley. These two summer observations indicate that some Gyrfalcons may breed in the area. This assumption is supported by observations made by Mossop (personal communication) in the Chilkat Pass area.

*Most observations were of the "Harlan's Hawk" type.

FIGURE 3. Male Willow Ptarmigan in subalpine shrub zone along Sheep Creek.

PEREGRINE FALCON. *Falco peregrinus.* Probably a migrant in this region. The author is very familiar with these birds because of frequent observations of captive falcons held in the Whitehorse Game Farm. Two were observed on June 11, 1970, in the Duke River Delta area, and one pair on October 19 and 20, 1970, near Sheep Mountain.

PIGEON HAWK. *Falco columbarius.* Occasional.

SPARROW HAWK. *Falco sparverius.* Common; +.

SPRUCE GROUSE. *Canachites canadensis.* Common; +.

RUFFED GROUSE. *Bonasa umbellus.* Only two observations: September 10, 1971, a single cock at the base of Sheep Mountain; September 5, 1970, a dead bird along the Alaska Highway near the Donjek River.

WILLOW PTARMIGAN. *Lagopus lagopus.* (Figure 3). Abundant; +.

ROCK PTARMIGAN. *Lagopus mutus.* (Figure 4). Frequent; +.

WHITE-TAILED PTARMIGAN. *Lagopus leucurus.* (Figure 5). Frequent; +.

SHARP-TAILED GROUSE. *Pedioecetes phasianellus.* This grouse was observed only in the "Duke Meadow," where it is fairly common. The "Duke Meadow" is a prairie–aspen parkland association occupying an abandoned stream bed of the Duke River.

SANDHILL CRANE. *Grus canadensis.* Single pairs were seen during late April 1970 and 1971 in the Slims River flats.

FIGURE 4. Male Rock Ptarmigan in subalpine shrub zone of Burwash Uplands.

FIGURE 5. White-tailed Ptarmigan in alpine boulder field on north slope of Sheep Mountain.

SEMIPALMATED PLOVER. *Charadrius semipalmatus.* Common; +.

KILLDEER. *Charadrius vociferus.* Four were observed at the Duke River Delta on May 30, 1970. Two individuals, first observed in the same area on May 15, 1971, were seen several times till late June. Their behavior suggested breeding. Five were observed on June 8, 1972, near Cultus Bay, southeastern Kluane Lake. One of these was entirely white except for a faint grayish indication of the neck bands. Two were seen in the Koidern River area on June 21, 1972. Mike Williams, Mile 1054 Alaska Highway, told me that he accidentally killed two Killdeer chicks at the south end of Kluane Lake some years ago. It appears that the Killdeer has become established in the Kluane area only recently.

AMERICAN GOLDEN PLOVER. *Pluvialis dominica.* Occasional; +.

COMMON SNIPE. *Capella gallinago.* Occasional; (+).

WHIMBREL. *Numenius phaeopus.* One was seen at a pond in the Slims River floodplain on June 20, 1971. A group accompanying Mr. Oosenbrug, University of Waterloo, on a caribou survey, discovered a large concentration area on the "Burwash Uplands" on June 14, 1973. The "Burwash Uplands" are an extensive sub-alpine plateau with many wet sedge meadows, where at least a dozen Whimbrels were found. It is assumed that they breed in this area. On this plateau we also found many American Golden Plovers and two nests with four eggs each, and many pairs of Smith's Longspurs, presumably also breeding in this area.

UPLAND PLOVER. *Bartramia longicauda.* Common; +.

SPOTTED SANDPIPER. *Actitis macularia.* Common; +.

SOLITARY SANDPIPER. *Tringa solitaria.* Frequent; +.

WANDERING TATTLER. *Heteroscelus incanum.* One was observed by Ken Summers at the headwaters of Quill Creek on June 27, 1972. Theberge (personal communication) saw one near Silver Creek (Dalton Post area). Mossop (personal communication) reported having seen these birds on a few occasions on the Chilkat Pass south of Kluane National Park.

GREATER YELLOWLEGS. *Totanus melanoleucus.* Two were observed in a flock of six Lesser Yellowlegs at a small pond in the Slims River floodplain on May 20, 1969.

LESSER YELLOWLEGS. *Totanus flavipes.* Common; +.

PECTORAL SANDPIPER. *Erolia melanotos.* Flocks of three birds were observed from August 20 to 22, 1972. on an alpine plateau above Bullion Creek. They were feeding in a moist *Salix polaris–Oxyria digyna* association.

LEAST SANDPIPER. *Erolia minutilla.* Frequent; +.

DUNLIN. *Erolia alpina.* One was observed on June 4, 1972, at the mouth of the Duke River in a flock of four Dowitchers. This species has not been reported for this area.

SHORT-BILLED DOWITCHER. *Limnodromus griseus.* Frequent; (+).

LONG-BILLED DOWITCHER *Limnodromus scolopaceus.* A single bird provisionally identified as of this species was seen on May 16, 1971, in the Duke River Delta. Because of its great similarity to the Short-billed Dowitcher confusion is possible, since the latter species had been encountered in the area on several previous occasions.

SEMIPALMATED SANDPIPER *Ereunetes pusillus.* Occasional.

SANDERLING. *Crocethia alba.* A flock of six was positively identified at close range on a sandy shore of Kluane Lake (Mile 1069) on September 10, 1969. Four were observed on September 9, 1972, at Mile 1071, Kluane Lake. Both of these sightings were made during fall migration. There is no previous record for the Kluane area .

NORTHERN PHALAROPE. *Lobipes lobatus.* Common. +.

LONG-TAILED JAEGER. *Stercorarius longicaudus.* Single birds were seen over Kluane Lake near Mile 1070 on June 20, 1970, and July 10, 1971; near the headwaters of Quill Creek on June 27, 1972; and near the terminus of the Kashawulsh Glacier on August 5, 1972.

HERRING GULL. *Larus argentatus.* Common; +.

MEW GULL. *Larus canus.* Common; +.

BONAPARTE'S GULL. *Larus philadelphia.* Frequent; (+).

ARCTIC TERN. *Sterna paradisaea.* Common; +.

MOURNING DOVE. *Zenaidura macroura.* Two were observed for a period of one week in early June 1969, in an aspen bluff near the Slims River Delta.

GREAT HORNED OWL. *Bubo virginianus.* Frequent; (+).

SNOWY OWL. *Nyctea scandiaca.* One observation. On November 10, 1970, a Snowy Owl was feeding on a snowshoe hare at the Alaska Highway near Bear Creek summit.

HAWK OWL. *Surnia ulula.* Frequent; (+).

GREAT GRAY OWL. *Strix nebulosa.* Occasional; (+).

SHORT-EARED OWL. *Asio flammeus.* Occasional; +.

COMMON NIGHTHAWK. *Chordeiles minor.* Occasional.

BELTED KINGFISHER. *Megaceryle alcyon.* Occasional.

YELLOW-SHAFTED FLICKER. *Colaptes auratus.* Frequent; +.

HAIRY WOODPECKER. *Dendrocopos villosus.* Occasional; (+).

DOWNY WOOPECKER. *Dendrocopos pubescens.* Rare.

BLACK-BACKED THREE-TOED WOODPECKER. *Picoides arcticus.* Rare.

NORTHERN THREE-TOED WOODPECKER. *Picoides tridactylus.* Frequent; (+).

SAY'S PHOBE. *Sayornis saya.* Common; +.

HAMMOND'S FLYCATCHER. *Empidonax hammondii.* Occasional.

DUSKY FLYCATCHER. *Empidonax oberholseri.* One observation. On May 27, a single bird, tentatively identified as one of this species, was seen in an open poplar stand at the base of Sheep Mountain. Identification was uncertain because of poor light conditions in the evening.

WESTERN WOOD PEWEE. *Contopus sordidulus.* Frequent; (+).

OLIVE-SIDED FLYCATCHER. *Nuttallornis borealis.* Occasional.

HORNED LARK. *Eremophila alpestris.* Common; +.

VIOLET-GREEN SWALLOW. *Tachycineta thalassina.* Common; +.

TREE SWALLOW. *Iridoprocne bicolor.* Rare.

BANK SWALLOW. *Riparia riparia.* Occasional; +.

BARN SWALLOW. *Hirundo rustica.* Common; +.

CLIFF SWALLOW. *Petrochelidon pyrrhonota.* Common; +.

GRAY JAY. *Perisoreus canadensis.* Abundant; +.

BLACK-BILLED MAGPIE. *Pica pica.* Common; +.

COMMON RAVEN. *Corvus corax.* Common; (+).

CLARK'S NUTCRACKER. *Nucifraga columbiana.* Single birds were seen on May 3, 1970 and May 4, 1970 and April 30, 1971. All these sightings were made in open poplar stands at the base of Sheep Mountain. This species has not been reported for the Kluane area before.

BLACK-CAPPED CHICKADEE. *Parus atricapillus.* Occasional.

BOREAL CHICKADEE. *Parus hudsonicus.* Common; (+).

RED-BREASTED NUTHATCH. *Sitta canadensis.* Single birds were observed on September 30, 1970 in dense spruce forest near Mile 1062 Alaska Highway, and on August 28, 1972 in an isolated patch of spruce in the sub-alpine shrub zone on the west slope of Sheep Mountain.

DIPPER. *Cinclus mexicanus.* Dr. V. Geist and the author observed two single birds on July 28 and 29, 1971, in the Lynx Creek area. On July 7, 1972 a Dipper was seen at the upper Kathleen Lake.

ROBIN. *Turdus migratorius.* Common; +.

VARIED THRUSH. *Ixoreus naevius.* Occasional.

HERMIT THRUSH. *Hylocichla guttata.* Occasional; (+).

SWAINSON'S THRUSH. *Hylocichla ustulata.* Frequent; (+).

GRAY-CHEEKED THRUSH. *Hylocichla minima.* One was observed on July 5, 1972 in the Sockeye Lake area. This thrush appears to be restricted to the southernmost portion of the Kluane area, where it was also observed by Mossop (personal communication).

MOUNTAIN BLUEBIRD. *Sialia currucoides.* Occasional; +.

WHEATEAR. *Oenanthe oenanthe.* An adult and four young were seen on an alpine plateau near the terminus of the Donjek Glacier on July 19, 1972. Three immature birds were observed on an alpine plateau above Bullion Creek in early August 1972 for three consecutive days.

TOWNSEND'S SOLITAIRE. *Myadestes townsendi.* Common; +.

GOLDEN-CROWNED KINGLET. *Regulus satrapa.* Rare.

RUBY-CROWNED KINGLET. *Regulus calendula.* Frequent; (+).

WATER PIPIT. *Anthus spinoletta.* Common; +.

BOHEMIAN WAXWING. *Bombycilla garrulus.* Frequent; +.

NORTHERN SHRIKE. *Lanius excubitor.* Occasional.

STARLING. *Sturnus vulgaris.* One was observed at our camp at Kluane Lake, Mile 1054, on April 23 and 24, 1971. During the summer of 1970 several were observed around the Experimental Farm, Mile 1019 and around the Whitehorse garbage dump, where they presumably breed. These are the first sightings of Starlings in the Kluane area.

ORANGE-CROWNED WARBLER. *Vermivora celata.* Rare.

YELLOW WARBLER. *Dendroica petechia.* Frequent; (+).

MYRTLE WARBLER. *Dendroica coronata.* Common: +.

AUDUBON'S WARBLER. *Dendroica auduboni.* On May 30, 1970, one was seen in an open spruce stand near the Duke Meadow. At close range the yellow throat was positively seen. There is no previous record of this warbler for the Kluane area.

BLACKPOLL WARBLER. *Dendroica striata.* Rare.

PALM WARBLER. *Dendroica palmarum.* Flocks of up to a dozen birds were observed during spring migration (second week of May 1972) on several consecutive days. They were feeding in tall willows in the Slims River floodplain. A single bird was seen on June 30, 1972, at Mile 1070 in an open willow–spruce association at Kluane Lake. This warbler has not been reported previously for the Kluane area.

NORTHERN WATERTHUSH. *Seiurus noveboracensis.* On September 9, 1972, at Mile 1062, the author observed one feeding at the edge of a small pond. Ken Summers heard this species on June 22, 1972, in the Koidern River area. This warbler has not been reported for the Kluane area.

YELLOWTHROAT. *Geothlypis trichas.* Two were observed by Ken Summers at Mile 1018 on July 17, 1972. Theberge (personal communication) observed one near Alder Creek (Mush Lake area) in late July 1972.

WILSON'S WARBLER. *Wilsonia pusilla.* Common; +.

AMERICAN REDSTART. *Setophaga ruticilla.* A pair was observed throughout May and June 1969 in an open spruce–willow association on the gravel beds of Sheep Creek. A nest with three eggs was located in a tall willow. The birds did not return to this area in subsequent summers. This species has not been reported previously for the Kluane region.

RED-WINGED BLACKBIRD. *Agelaius phoeniceus.* Two pairs and one nest with three young were located along a marshy shore of the Slims River, only 3 miles from the terminus of the Kaskawulsh Glacier on June 10 and 11, 1971. Breeding pairs were also observed at Sulphur Lake and at the Yukon Game Farm, west of Whitehorse. During the 1972 season three birds were again observed in the Kaskawulsh area, and four pairs and one nest with four young were seen in the Koidern River area on June 22, 1972. These are the first breeding records of this species for the Kluane area.

RUSTY BLACKBIRD. *Euphagus carolinus.* Frequent; +.
BROWN-HEADED COWBIRD. *Molothrus ater.* Five were observed near Mile 1018, associated with a small herd of cattle on June 17, 1972.

PINE GROSBEAK. *Pinicola enucleator.* On April 12, 1971, one was seen in a tall, dense spruce forest near Mile 1057. This species is rare in the area, but has been reported for the upper Yukon by White and Haugh (1969).

GRAY-CROWNED ROSY FINCH. *Leucosticte tephrocotis.* Frequent; +.

COMMON REDPOLL. *Acanthis flammea.* Frequent; (+).

PINE SISKIN. *Spinus pinus.* Frequent.

RED CROSSBILL. *Loxia curvirostra.* Rare.

WHITE-WINGED CROSSBILL. *Loxia leucoptera.* Common; (+).

SAVANNAH SPARROW. *Passerculus sandwichensis.* Common; +.

SLATE-COLORED JUNCO. *Junco hyemalis.* Abundant; +.

TREE SPARROW. *Spizella arborea.* Frequent; +.

CHIPPING SPARROW. *Spizella passerina.* Common; +.

BREWER'S SPARROW. *Spizella breweri.* This sparrow was observed on several occasions during 1972 and was always associated with the sub-alpine shrub zone. On June 19 two were observed near the Donjek Glacier terminus; on June 27 three near the headwaters of Quill Creek; and three on several days during June and July above Bullion Creek.

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys.* Abundant; +.

GOLDEN-CROWNED SPARROW. *Zonotrichia atricapilla.* Occasional; +.

FOX SPARROW. *Passerella iliaca.* Occasional.

LINCOLN'S SPARROW. *Melospiza lincolnii.* Occasional.

LAPLAND LONGSPUR. *Calcarius lapponicus.* Frequent.

SMITH'S LONGSPUR. *Calcarius pictus.* Occasional; (+).

SNOW BUNTING. *Plectrophenax nivalis.* Occasional; (+).

The following 35 species, not seen by the author, were observed by others in and near the Kluane Game Sanctuary as noted earlier.

Red-throated Loon
Red-necked Grebe
Pied-billed Grebe
Redhead
Ruddy Duck
*Swainson's Hawk
Ring-necked Pheasant
Whooping Crane
Baird's Sandpiper
Western Sandpiper
*Hudsonian Godwit
California Gull
Barred Owl
*Rufous Hummingbird
Eastern Kingbird
Eastern Phoebe
Traill's Flycatcher
Least Flycatcher
Steller's Jay
Common Crow
Mountain Chickadee
Brown Creeper
Brown Thrasher
Solitary Vireo
Townsend's Warbler
MacGillivray's Warbler
Brewer's Blackbird
Western Tanager
Purple Finch
Hoary Redpoll
American Goldfinch
Harris' Sparrow
White-throated Sparrow
Swamp Sparrow
Song Sparrow

*Recorded outside the Yukon Territory.

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Literature Cited

Banfield, A. W. F. 1953. Notes on the birds of Kluane Game Sanctuary, Yukon Territory. Cana-Kluance Game Sanctuary, Yukon Territory. Canadian Field-Naturalist 67: 177–179.

Bostock, H. S. 1948. Physiography of the Canadian Cordillera, with special reference to the area north of the 55th parallel. Canada Geological Survey, Memoir 247.

Bushnell, V. C. and **R. H. Ragle** (*Editors*). 1970. Icefield Ranges Research Project scientific results. Volume I. American Geographical Society and Arctic Institute of North America.

Bushnell, V. C. and **R. H. Ragle** (*Editors*). 1969. Icefield Ranges Research Project scientific results. Volume II. American Geographical Society and Arctic Institute of North America.

Buss, I. O. 1951. The Upland Plover in southwestern Yukon Territory. Arctic 4(3): 204–213.

Clarke, C. H. D. 1945. Some bird records for Yukon Territory. Canadian Field-Naturalist 59: 65.

Drury, W. H., Jr. (1953). Birds of the Saint Elias Quadrangle in the southwestern Yukon Territory. Canadian Field-Naturalist 67: 103–128.

Fisher, M. (*Editor*). Undated. Expedition Yukon. Thomas Nelson and Sons, Ltd.

Godfrey, W. E. 1951. Notes on the birds of southern Yukon Territory. National Museum of Canada, Bulletin Number 123. pp. 88–115.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada, Bulletin Number 203, Biological Series No. 73.

Hoefs, M. and **W. G. Benjey.** 1971. The Park in perpetual planning: The Kluane Park Reserve, Yukon. Canadian Field-Natura ist 85(3): 261–265.

Kindle, E. D. 1953. Dezadeash Map-Area, Yukon Territory. Geological Survey of Canada, Memoir 268.

Laing, H. M., P. A. Taverner, and **R. M. Anderson.** 1929. Birds and mammals of the Mount Logan Expedition. National Museum of Canada, Bulletin Number 56. pp. 69–107.

Muller, J. E. 1967. Kluane Lake Map-Area, Yukon Territory. Geological Survey of Canada, Memoir 340.

Porsild, A. E. 1966. Contribution to the flora of the southwestern Yukon Territory. National Museum of Canada, Bulletin Number 216.

Price, L. W. 1969. Nesting of the Long-tailed Jaeger in southwest Yukon Territory — an extension of the known breeding grounds. Canadian Field-Naturalist 83: 138–141.

Soper, J. D. 1954. Waterfowl and other ornithological investigations in the Yukon Territory, Canada, 1950. Canadian Wildlife Service, Wildlife Management Bulletin Number 4. Series 2.

Tasker, R. R. Undated. Fauna observations. *In* Expedition Yukon. *Edited* by M. Fisher. Thomas Nelson and Sons Ltd.

Weeden, R. B. 1960. The birds of Chilkat Pass, British Columbia. Canadian Field-Naturalist 74(2): 119–129.

White, C. M. and **J. R. Haugh.** 1969. Recent data on summer birds of the upper Yukon River, Alaska, and adjacent parts of the Yukon Territory, Canada. Canadian Field-Naturalist 83: 257-271.

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Movement and Rutting Behavior of Caribou (*Rangifer tarandus*) at Mount Albert, Quebec

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Bergerud, A. T. 1973. Movement and rutting behavior of Caribou (*Rangifer tarandus*) *at* Mount Albert, Quebec. Canadian Field-Naturalist 87: 357-369.

Abstract. A caribou population of about 166 animals was observed at Mt. Albert, Quebec, from September 12 to October 29, 1959. There was on constant turnover of animals seen in an open plateau on top of the mountain. Possibly many of the does came to the plateau shortly before estrus. Stags were continually coming and going, possibly searching for females with which they could associate. Rutting companies of caribou were temporary associations of females, one dominant stag, and subordinate stags. Dominant stags herded females and chased subordinate males. These groups were not harems since there was no fixed social attachment between individuals. Individual animals recognized each other and there was rank hierarchy among 26 stags. Large antlered stags near the top of the hierarchy bred most of the does in the period September 27 to October 17. The peak of breeding occurred about October 7.

Introduction and Methods

The rutting behavior of caribou (*Rangifer tarandus*) has been studied by Espmark (1964a) and Lent (1965). Espmark (1964b) studied captive reindeer in which there was a well developed rank hierarchy. Espmark characterized the herd structure as a harem type with a dominant male that bred most of the females. Lent (1965) studied the rut of barren-ground caribou that were migrating in large herds when breeding occurred. The herd structure was open, and individuals were not members of a special social group. Breeding was accomplished by males associating with and defending specific females in heat. In a later paper, Lent (1966) argued that barren-ground animals recognize sex and age classes and that dominance hierarchies are based on classes rather than on individuals.

I studied the rut of caribou from September 12 to October 29, 1959 at Mount Albert on the Gaspé Peninsula, Quebec (see Moisan 1955). This study contained some of the observational components of the studies of both Espmark and Lent and may allow a further synthesis of the apparent contrasting results of these two reports. The Mount Albert herd contained fewer than 200 animals and their breeding activity appeared to be restricted to an open plateau of 5.5 square miles although the animals were free to move from the plateau to the forest below the mountain, and frequently did so. I was able to recognize 108 animals in the herd by antler configurations. I drew two-dimensional antler diagrams on flash cards and trained myself to recognize animals quickly.

Description of Area

The Gaspé Peninsula is bounded on the north by the St. Lawrence River, to the west by the Matapedia Valley, and by the Bay of Chaleur to the south. The peninsula measures approximately 80 × 150 miles, with an area of 11,000 square miles. The Shickshock Mountains in the center of the peninsula reach an elevation of 4,000 feet.

The peninsula is in the Canadian biotic province (Dice 1943) with a typical boreal forest. The dominant species are white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), and paper birch (*Betula papyrifera*).

Moisan (1955) described Mount Albert in this way: "Mt. Albert is one of the lofty peaks of the Shickshocks, 26 miles south of the village of Ste. Anne des Monts. The Mountain consists of a mass of serpentine surrounded by altered volcanic rocks. It is a steep-walled table land, 3.5 miles long and 2.5 miles wide; the

summit, 3,700 feet, is treeless, rock-strewn, with here and there a pond. Mt. Albert is timbered almost to the summit on the north and east sides, but trees growing above 2,000 feet are too small for logging."

Observations and Results

Herd Size

I observed a total of 1,477 animals during the months of September and October and classified 438 of these as to sex and age (Table 1). Many recognizable animals, based on antler characteristics, were seen repeatedly. A comparison of the herd composition data and the known antlered animals suggested a minimum population of 166 animals (Table 1).

Movement and Herd Structure

On the first trip to the top of Mount Albert on September 12, seven females were observed associated with a stag that showed sexual interest in the females. No animals were seen September 13 to 15. From September 16 to 25, 33 animals were identified by antler diagrams; six animals were on the peak on two successive days; only one animal for three consecutive days. Caribou did not remain on the top consistently until September 26. Many of the animals that were seen on the mountain left and returned 8 to 26 days later (Table 2).

In October when breeding occurred, the rutting company consisted of from two to as many as 69 does aggregated together and attended by one to 14 stags. However, there was

TABLE 1. — Herd composition, Mount Albert, October 1959, based on segregation counts and the identification of known animals by antler diagrams

Herd composition	Classified sample	Percent	Antler diagrams, total	Percent
Large antlered stags	33	7.6	15	8.5
Medium antlered stags	28	6.4	13	7.9
Small antlered stags	23	5.2	8+(2)*	6.1
2-year-old stags	18	4.1	5	3.1
Adult stag total	102	23.3	43	25.6
Antlered does	150	34.2	51	30.5
Unantlered does	77	17.6	(26)	15.8
Adult doe total	227	51.8	76	46.8
Yearling male	14	3.2	7	4.3
Yearling female	20	4.6	7+(4)**	6.7
Yearling total	34	7.8	18	11.0
Calf male	30+(21)****	11.6	12+(7)***	11.6
Calf female	14+(10)****	5.5	6+(3)***	5.5
Calf total	75	17.1	28	17.1
Total sample	438	100.0	166	100.0
Stags/100 does		44.9		55.3
Calves/100 does		33.0		35.5
Yearlings/100 does		14.9		23.7
Unantlered does/100 antlered does		51.3		52.0

*Two unantlered stags added.
**Four unantlered yearling females calculated and added.
***Eighteen calves sexed and identified by correlation with mother's antlers; 10 calves (of unantlered does) added in same sex ratio.
****Thirty-one calves from classified count, sex unknown, added in same sex ratio as 18 calves sexed.

TABLE 2. — Daily population turnover in rutting company where Stag 8 was dominant

Date	Total in herd	Antlered does					Stags	
		Total	Turn-over from prior day					
			Stayed	Arrived	Left	%	Total	Turnover
10/1	6	3	—	—	—	—	1	—
10/2	13	4	2	2	1	50.0	4	75.0
10/3	48	18	4	14	0	77.8**	13	84.6
10/4	48	24	14	10	4	41.7	10	30.0
10/5	53	26	24	2	0	7.7	11	54.5
10/6	55	26	19	7	7	26.9	9	44.4
10/7	58	29	24	5	2	17.2	12	50.0
10/8	60	32	28	4	1	12.5	14	42.9
10/9	69	29	26	3	6	10.3	13	23.1
10/10	60	32	25	7	4	21.9	12	8.3
10/11	47	28	25	3	7	10.7	8	25.0
10/12	37*	?	?	?	?	?	?	?
Mean	46	23	19	6	3	28	10	44

*Stag 8 lost interest and group was breaking up.
**Excessive figure: not all does identified.
***Known does were absent from the mountain an average of 12.5 days (range 10–14 days) while stages were absent an average 15.2 days (range 8–26 days).

always only one stag that was clearly dominant per group. During bouts of sexual activity this stag attempted to keep the does from leaving the aggregation, and the subordinate stags from associating with the females. His activity was not continuous, however, and during inactive spells females commonly left the group and subordinate stags associated with females. There was only one such group on the mountain on most days, but occasionally there were two, three, or four such groups.

On September 18 five does were dominated by large antlered Stag 1 (Figure 1; see Figure 4 for diagram of his antlers). He was again in charge of some does on September 19 but then left the mountain and did not return until October 7. The next observed dominant stag associating with does was Stag 13 on September 24 (Figure 1). He was absent the next day and Stag 16 was associated with those females present. On September 26 there were four rutting companies with large Stags 8, 13, 18, and medium Stag 21 the dominant males. Stag 13 was also the dominant male with does on September 27, 28, and 29.

In the period October 1 to 15, Stag 8 (Figure 2) was always found with the largest group of females on the mountain and was the dominant stag present. There was a large daily turnover of animals from this rutting company (Table 2). All the antlered animals were identified on 10 of the 16 days that Stag 8 was the dominant male. Nine does were present on only one day and only two does were present all 10 days (mean days does present 5.5). Many stags were with the herd on only one day (mean days stags present 3.3).

Stags were continually coming and going, presumably searching for does. Only Stag 8 remained the entire period October 1 to 15. The second ranking Stag 25 was present October 5 to 10. Stag 13 was in charge of a rutting company on October 1 and again on October 11. After that date Stag 13 left and Stag 8 re-

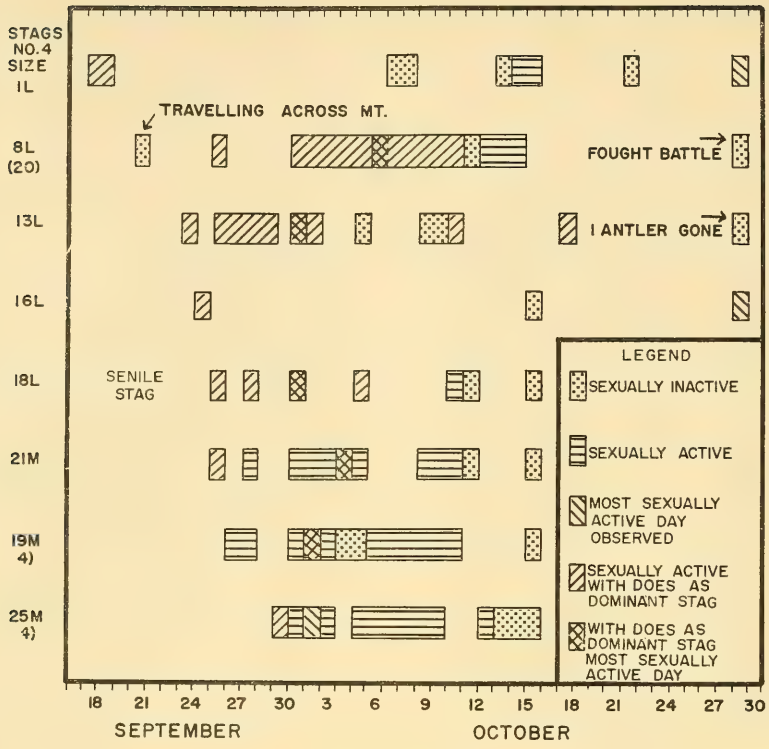

FIGURE 1. Comparison of the duration of sexual activity of eight stags. The letters M and L beside a stag's number represent medium size stag and large stag. On dates without cross-hatching the stags were not seen and were likely not on the mountain.

mained with all the does. The build-up reached 69 does associated with Stag 8 on October 9. By October 12 this group had decreased to 37 does (Table 2).

Dominant stags had some influence on group structure. The longer duration on the mountain of females than males may be due not only to their need to be served, but also to the threatening and herding behavior of the dominant males. Three instances were recorded of the stag leaving the group and walking out to meet does and chasing them into the herd. On the morning of October 8, Stag 8 had 60 caribou with him. From 2:00 p.m. to 4:35 p.m., the weather turned warm and Stag 8 was inactive. During this period, members of the group drifted away in small groups. At 4:30 p.m. only 23 caribou remained. At 5:00 p.m., with a drop in temperature, Stag 8 became active again in herding and chasing the does. The next day there were 69 does in the group.

When the does moved off as a feeding group, the dominant stag of each group did not hinder their progress. At times, does followed stags during feeding movements.

Stag Agonistic Behavior

Large antlered stags threatened smaller antlered stags by presenting their antlers. They lowered their heads so that the antlers were low and pointing forward. Often the threat was a brief antler tilt or nod.

Large stags also chased smaller stags, especially if the subordinate stag ran at the does in a licking display which I have called "slurping." The notes taken on October 11 illustrate this.

FIGURE 2. Stag 8, the dominant stag on the mountain.

12:33 p.m. — Stag 8 chases Stag 30 hard. 12:45 — Stag 8 slurping in herd. 12:48 — Stag 8 chases Stag 32. 12:52 — Stag 8 and Stag 18 feeding near each other. 12:54 — Stag 8 chases Stag 30 who was with the does; Stag 18 also runs a few steps from Stag 8. 2:00 — Stag 8 gets up and is active chasing stags; he goes 200 yards to herd a doe back. 2:52 — Stags 19 and 9 in mock battle. 3:40 — Stag 8 chases Stag 30 who was slurping Doe 25. 3:50 — Stag 8 chases Stag 30 again when he slurps after Doe 25.

Large antlered stags occasionally made a hoarse, gutteral, panting sound. I believe this vocalization was an indication of dominance and had threat implications. Panting was addressed to males and to females that would not stand when they were being tended. I heard all 11 large stags that I watched for several days pant; two of the eight medium stags panted; one of the seven small stags panted (possibly 3½ years old), and none of the 12 yearlings and 2½-year stags panted.

Large antlered stags had interactions that involved either serious antler fighting, which I have called dominance battles, or if one stag showed avoidance behavior, the result was turning-aside behavior. Large stags seldom chased stags of approximately equal antler size.

Dominance battles were brief and serious and, at least once resulted in mortality. A description of a fight on October 2, 1959 illustrated this behavior.

> Stag 16 slurps (a licking display) at Doe 41 twice and is standing by her. She has a slight limp (mated previously?). She moves, which excites him, which in turn causes her to run and he chases hard and hits her twice with his antlers on the top of her back. As they near Stag 8 he starts running towards them. Stag 16 and Stag 8 angle in at each other and lock antlers. Stag 16 pushes Stag 8 several hundred feet downhill until Stag 8's hind feet collapse and he goes down. Even though he is down on the ground he manages to keep his head from getting turned and continues to face Stag 16. He gets to his feet, frees his antlers, and jumps clear. Stag 16 chases him a few yards and then begins smelling the ground and runs off in search of the doe. In a few minutes he is seen coming straight back to Stag 8 in an attempt to pick up the doe's scent again. As he approaches, Stag 8 commences to feed. Stag 16 turns and rushes off tracking with his nose to the ground.

This fight was interesting because throughout most of the study at Mount Albert, Stag 8 was the dominant stag on the mountain, associating at one time with 69 caribou. After October 11, Stag 8 was largely inactive (Figure 1). On October 16, Stags 8 and 16 were both inactive and were associated with a rutting company in which two does were in heat and were actively sought by other stags. The feeding movement of Stag 8 on the approach of Stag 16 is classified as agonistic feeding behavior and was seen on two other occasions when large stags were threatened and approached; rather than flee, they commenced to feed until the threatening stag had moved on.

The most violent fight observed occurred on October 7. The following is a description of this battle.

At 3:58 p.m. Stag 8 was standing in the center of the doe company of 51 caribou looking up the mountain and panting. Several hundred yards away, standing on the crest, was Stag 12 with one doe; he was also panting. As Stag 12 approached, Stag 8 left his herd and walked slowly, panting, up the slope towards Stag 12. As they neared each other (perhaps 25 feet) Stag 12 angled to the left (it appeared that he was going to turn aside). Stag 8 also turned and they touched antlers. The animals fought very hard for 10 seconds. Stag 8 was pushed 15 feet, which seemed to drive him to greater effort; he then pushed Stag 12, picking up momentum and was about to turn Stag 12 when Stag 12 broke contact and ran. Stag 8 caught him, head down, on the right side and bowled him over. For the next 7 minutes and 14 seconds Stag 8 kept his antlers against Stag 12 not letting him get up and rolling him over four times as he tried to regain his feet. The right bez tine of Stag 8 was deep in the abdominal cavity of Stag 12. Only when Stag 12 stopped struggling did Stag 8 let up, and then he went back twice and put his head down and pushed with considerable

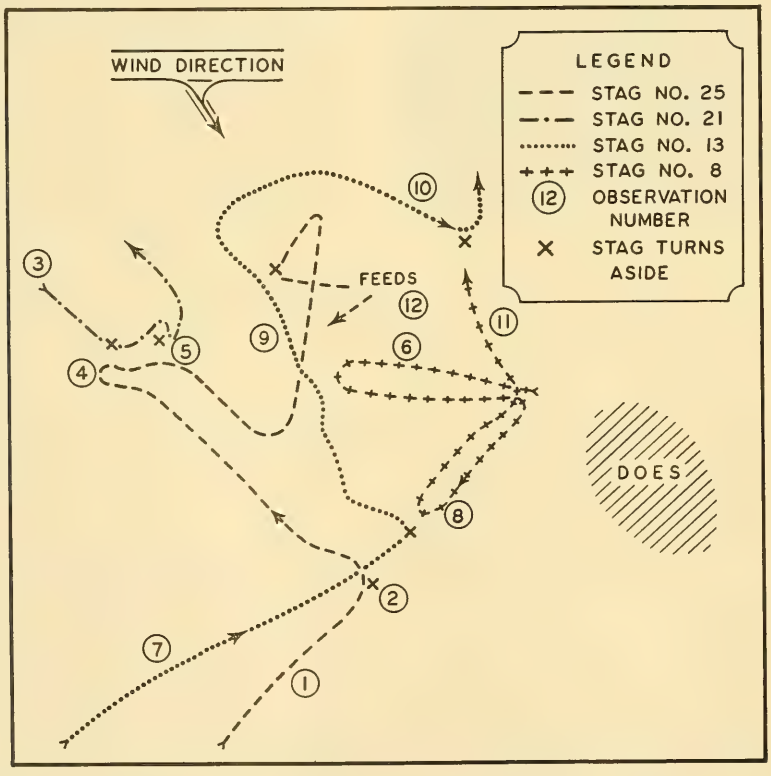

FIGURE 3. Movement of stags during threatening and turning-aside behavior, October 5. 1. 3:00 p.m. Stag 25 panting, approaches does with Stag 8. 2. 3:02 p.m. Stag 8 pants at Stag 25 who stops then turns aside. 3. 3:03 p.m. Stag 21 is approaching Stag 25 on his new route. 4. 3:05 p.m. Stag 25 moves toward Stag 21 who turns aside. 5. 3:10 p.m. Stag 21 turns and looks at Stag 25 who turns and comes back, they walk together and fight 7 seconds, Stag 25 wins. 6. 3:10 p.m. Stag 8 approaches standing stags and they separate and walk away. 7. 3:25 p.m. Stag 13 approaching herd. Stag 25 watching. 8. 3:29 p.m. Stag 8 approaches Stag 13 who turns aside. 9. 3:30 p.m. Stag 13 approaches Stag 25 who turns aside and starts to feed. 10. 3:40 p.m. Stag 13 again moving towards herd. 11. 3:44 p.m. Stag 8 approaches Stag 13 who turns aside. 12. 3:46 p.m. Stag 8 chases Stag 25.

strength on the hind quarters of Stag 12. Stag 8 finally walked away but continued to watch Stag 12 for several minutes. When I approached the dying stag I found both of his left legs had compound fractures with the bones completely severed.

After his fight, many of the females showed interest in the struggling of Stag 12. After Stag 8 left and the group moved off, many of the does started to run, jump, and buck in an excitement display I have not since witnessed.

The turning-aside movement most frequently occurred when a large stag was approaching a rutting company dominated by another large stag. The resident stag would leave the herd and advance slowly toward the panting challenger stag. The newcomer would hold his course until the master stag was nearly on him then turn, slowly moving off so that the antlers of the two animals would not touch. The dominant stag then panted, turned, and retraced his steps back to the does. Occasionally the newcomer then stopped, looked over his shoulder and

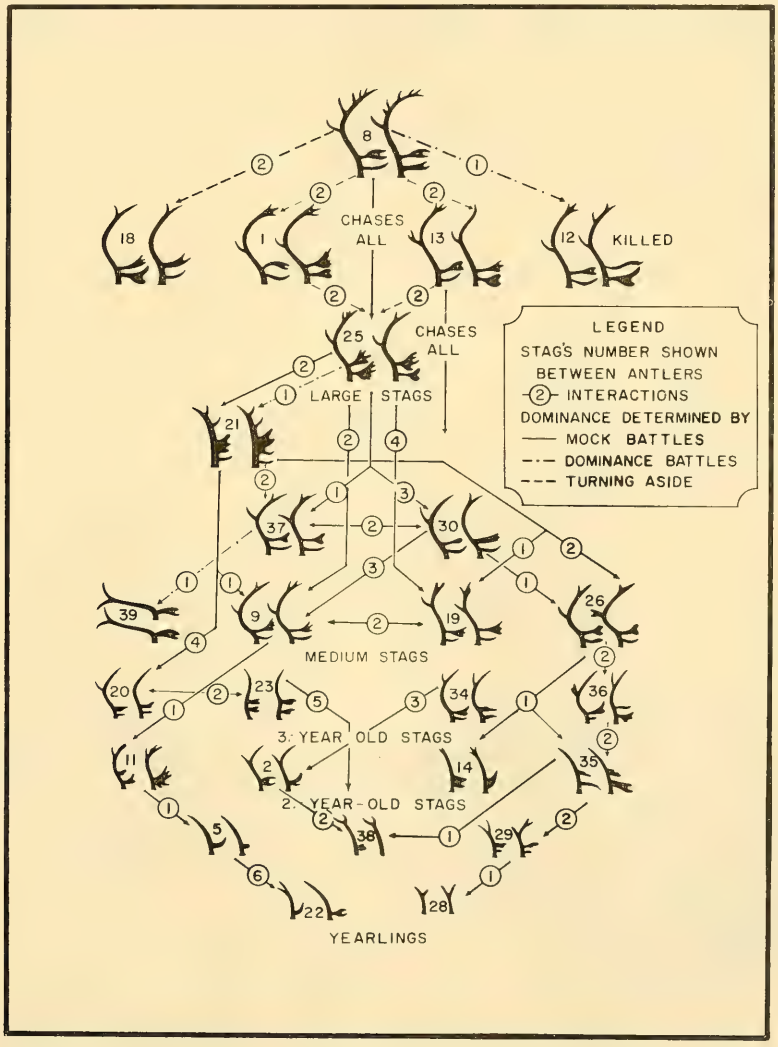

FIGURE 4. The dominance hierarchy of 26 stags based on 74 interactions.

again approached the company, whereupon the pattern was repeated.

The approach of Stag 25 and Stag 13 on October 5 demonstrated this threatening behavior (Figure 3). Stag 25 was usually associated with the does with Stag 8 but keeping well away from him. He established himself as the second ranking member by defeating Stag 21 in a dominance battle on October 5. It was his habit as the second ranking male to approach new stags and establish his position over them by sparring.

Yearlings and small- and medium-antlered stags frequently sparred in non-belligerent fighting which I have called mock battles. These sparring matches were continually in progress and it was not unusual to see three pairs of stags sparring at the same moment at Mount Albert. Yearlings were not always conditioned to the punishment they received. Two yearlings at Mount Albert were seen to disengage with considerable shaking of their heads with one of these animals running and bucking after breaking off the action; this is similar to calf behavior.

Figure 4 graphically portrays the results of 64 mock battles at Mount Albert. No interactions were recorded between medium and yearling stags. Yearlings and two-year-old stags commonly sparred together, the younger animals invariably quitting first. Likewise, small stags (most three-year-old animals) dominated over two-year-olds. Medium stags most frequently sparred among themselves. In six matches the superior animal could not be distinguished (Figure 4). As a rule, large stags did not spar. An exception was Stag 25 who was in an intermediate position between the truly large stags and the average medium-sized animal.

FIGURE 5. A tending stag approaching a doe in a low-stretch position, licking (a slurping display).

No reversals in the dominance ranking between partners was observed. Even though one partner continually perservered, there was seldom any hesitation on the subordinate partner's behalf to commence the action again. A common procedure after disengaging was that the animals walked side by side a few steps; one animal would lower his head as a sign to commence the action again, and the other animal obliged. Another common practice was that in which the dominant individual followed his partner who commonly started to feed. The aggresive individual then advanced on the feeding animal with his head lowered so that their antlers became meshed together. Frequently an aggressive animal meshed antlers with a reclining stag, and the action began. New individuals to a herd were readily sought out and tested; examples are Stags 9 and 38 in Figure 4. Two antlerless stags, "hummels,' were each seen to butt heads momentarily with small antlered stags. Sparring stags did not stimulate dominant masters, and sparring stags were seldom threatened or chased (only four observations).

TABLE 3. — Comparison of date of arrival of doe on the mountain with date she was seen being tended (slurped) by a stag

Doe Number	Date first seen	Date doe remained on mountain	Dates tended	Days between date doe first seen and date doe seen tended	Days between date doe remained on Mountain (seen each day) and date doe seen tended
1*	9/18	10/3	10/7	19	4
2	9/18	9/26	10/5	16	9
3*	9/18	10/3	10/8	20	5
4*	9/19	9/26	9/26, 10/2	7	0
8*	9/19	10/4	10/7	18	3
9*	9/19	10/3	10/3	14	0
10*	9/19	10/4	10/11	22	7
17**	9/26	9/26	10/16, 10/18	20	20
19	9/28	9/28	9/30	2	2
21	9/27	9/27	9/28, 10/9	1	1
22	9/29	10/7	9/30, 10/9	1	2
25	10/1	10/1	10/1, 10/11	0	0
26	10/2	10/2	10/2	0	0
29	10/3	10/3	10/11, 10/14	8	8
31	10/4	10/4	10/5, 10/6	1	1
33	10/4	10/4	10/8	4	4
36	10/4	10/7	10/8	4	1
41	10/6	10/6	10/7, 10/10, 10/29	1	1
43	10/6	10/6	10/15	9	9
46	10/8	10/8	10/11, 10/14, 10/15	3	3
49	10/10	10/10	10/10	0	0
50	10/11	10/11	10/11	0	0
52	10/14	?	10/14	0	0
55	10/16	10/16	10/16	0	0
59	10/18	10/18	10/18	0	0
Means				6.8	2.5

*Associated with Stag 1, September 18.
**Gone four days, October 2–5.

Breeding of Females

During the study, I observed only three copulations. These were on October 3, 7, and 11.

In Newfoundland, when a doe was approaching heat she was actively tended and courted by stags (personal files). The most common tending display was one in which the stag ran at the doe's head region in a low-stretch posture, licking his tonque in and out to make a slurping sound (Figure 5). This same courtship slurping was the tending pattern at Mount Albert. I feel that the number of different recognizable does being courted (slurped) would serve as an index of the dates of breeding at Mount Albert.

The number of antlered does being slurped reached a peak on October 7 (Figure 6). Slurping activity was reduced on October 6, and October 9 and 10. These were days of in-

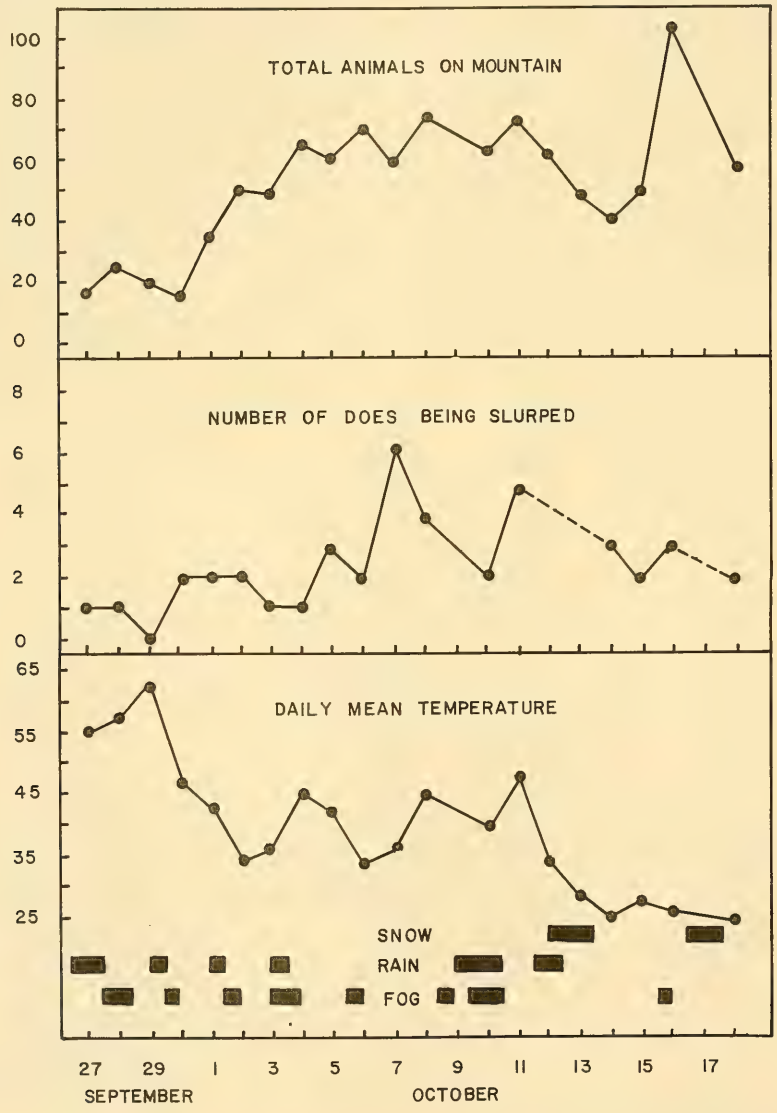

FIGURE 6. A comparison of the total animals observed, number of does being tended by slurping display, and weather statistics.

clement weather (Figure 6). Increased sexual activity of stags occurred on October 5, 7, and 11, days of clear dry weather.

Nine of the does that were tended arrived on the plateau on the same day that they were courted (Table 3). Ten other females that were tended arrived 1 to 4 days prior to courtship. This sequence may mean that females came to the plateau shortly before estrus.

Breeding Status of Stags

The mature stags were sexually active for a period of at least a month (Table 4). They were not active continuously for this interval but had rest periods amounting, at times, to several days (Figure 1).

TABLE 4. — Relation of antler size to duration of sexual interest

Duration of sexual interest	Number of Stags*		
	Small antlered	Medium antlered	Large antlered
October 1–7	1	4	5
October 8–14	4	6	5
October 15–21	—	—	4
October 22–28	—	—	2

*Individual stags recognized by antler characteristics.

A brief summary of the activity of the dominant stag (Stag 8) is shown in Table 5. His breeding activity was at a high level for 5 days, October 3–7. He was not observed to feed, other than eating forage that was urinated on, from October 2 to October 9. His activity declined during a rainy spell on October 9 and 10 but increased in intensity again on October 11 with clearing weather. Stag 8 spent a significant portion of his time resting even at the peak of his activity interval (Table 6).

A dominance hierarchy existed between the stags at Mount Albert (Figure 4). Stag 8 was the dominant stag from October 1 to October 15, and was the sire in two of the three copulations observed. Interestingly, Stag 8 was defeated by Stag 16 on October 29 (Figure 1). Stag 16 was courting a doe at that late date and likely bred her. I feel that Stag 8 was exhausted by October 29 because of his continuous activity in the first two weeks of October. Stag 39 bred one doe without prior tending behavior. He approached her when she was reclining and as she got up he mounted her. Stags 13 and 18 courted and likely bred does. Also Stags 25, 21, and 19 may

TABLE 5. — Daily activity of Stag 8

Date	Activity
September 21	Travelling alone; passes near some does but does not join.
September 26	With three does; panting.
October 1	With three does; not very active; some panting; mostly feeding.
October 2	Does not prevent Stag 17 from joining does; mostly interested in Doe 26.
October 3	Active chasing stags; breeds Doe 9.
October 4	Quite active chasing stags and definitely herding does.
October 5	Very active panting, chasing, and slurping (See Table 11).
October 6	Continues very active; a good deal of slurping.
October 7	Continues active, chasing, and slurping; breeds antlerless doe; mortally wounds challenger.
October 8	Activity declines, mostly interested in the does; resting 2.00–4.35 (warm in afternoon).
October 9	Definitely chasing stags less; fog and rain.
October 10	Activity in spurts. In between activity other stags join herd. He is feeding today; fog and rain.
October 11	Activity increases; chasing and slurping.
October 12	Not active. Herd is breaking up. Snow and rain.
October 14	Seen to chase stags once.
October 15	Leaves the mountain.
October 29	Feeding on mountain alone. Stag 16 chases does nearby and they fight. Stag 8 is defeated.

TABLE 6. — A comparison of the activities of Stag 8 from 11.50 a.m. to 2.50 p.m. on October 5, 1959, at Mount Albert, Quebec

Activity	Percentage of time
Resting (lying down)	57
Standing, slow walking, bush-grazing	13
Panting	9
Herding does	7
Smelling scent of doe's urine	5
Bush-thrashing*	4
Chasing stags	4
Slurping	1
Total	100

*See Espmark (1964a) and Lent (1965) for descriptions.

have succeeded in servicing a few does. The other 17 stags in Figure 4 were active at the end of the breeding season and may have bred some late-estrus does. On balance, it appears that a dominance hierarchy between stags was an important factor in the breeding status of stags; stags near the top of the hierarchy bred most of the females.

Discussion

The movement of the caribou to the plateau in September and October could not be considered a migration (cf. Moisan 1955). Throughout the study, caribou moved freely between the timbered flanks and the plateau. Some individuals were gone 1 or 2 days, others 2 or 3 weeks. It is not known if, during their absence, the animals visited other open plateaus in the Shickshocks where there were other animals. The long absence of some of the large antlered males suggests this possibility. Many of the females were likely bred at Mount Albert since I saw 23 of 51 adult antlered females courted by males.

The caribou's utilization of Mount Albert in the fall is similar to a fall shuffle of animals in Newfoundland. The mobility of the animals in Newfoundland increased in mid-September when they moved to more open habitats than timber. This movement occurred after the fly season and after the deciduous shrubs had lost their leaves. There were probably few animals at Mount Albert in the summer because of lack of deciduous plant growth and because of insect abundance. With the advent of cool weather the animals appeared to increase their cruising radius and they appeared more frequently on the mountain. The plateau should be considered as only a segment of their fall range. The total different caribou visiting the mountain was at least 166 indiivduals, but usually less than one third were present on any one day. The entire summer range for this herd lies within 15 linear miles of the mountain (Moisan 1955). This distance could be covered in a few hours.

Breeding activity is probably facilitated if the habitat is open. It would be more difficult for large herds to form and keep in contact in closed-canopy forest. The females likely know where the open areas are in the Shickshocks and visit them when they are approaching estrus. A large stag, like Stag 8, that could dominate animals in such an area, would be able to sire a number of young.

The rutting companies comprising the Mount Albert herd could not be called a harem, if by harem we mean a continuous association of a dominant stag and the same does, in which the stag keeps the does together for breeding purposes. Stag 8 was the dominant stag on Mount Albert on several days, but females came and left the group of animals in which he was dominant.

From 1956 to 1962 I studied the group structure of caribou during the rut in Newfoundland. Breeding occurred either in small groups (usually less than 20 animals) in which there was one dominant stag, or in groups of 20 or more animals in which several large stags were present and took part in breeding females. Superficially, the small groups resembled harems because each group had only one dominant stag, and this stag often herded females and chased subordinate stags. However, when I learned to recognize individuals by antler diagrams it was obvious that there was a continual turnover of animals between companies similar to that at Mount Albert. Those groups also could not be called harems.

In October 1962, wildlife officers in Newfoundland studied the behavior of nine does and one stag on Brunette Island (7.5 square miles). The nine does were usually together and the stag joined them for breeding. When the does were in heat they stayed near the stag. Possibly this company could be called a harem since all ten animals were usually together. However, if there had been other large antlered males on the island, females might have moved between groups dominated by different males. The individuals on Brunette Island recognized each other and there was a very clear dominance hierarchy.

The two previous studies of rutting behavior in *Rangifer* (Espmark 1964a; Lent 1965) seem to have studied animals that represent two extremes in a familiarity continuum based on the ability of animals to recognize individuals. The reindeer that Espmark studied involved 16 animals in a 10-acre enclosure, while Lent studied large herds (two to 1000 animals) of free-ranging barren-ground caribou. Espmark's animals were forced to remain together, and a clear dominance hierarchy was evident (Espmark 1964b); he calls the group a harem. Lent reported no clear dominance hierarchy between individuals and speaks of rutting groups in which the composition was constantly changing.

The animals at Mount Albert and in Newfoundland could recognize individuals, and hierarchies existed. However, the animals could come and go, and I would agree with Lent that herd structure was open and would not describe these groups as harems or speak of "moving territory" as does Espmark (1964a).

I would also argue that if barren-ground caribou were confined so that they continually met, dominance hierarchies based on individual recognition would be evident. I would agree with Lent (1966) that dominance between age and sex classes is part of their behavior repertoire of the genus. At Mount Albert, large antlered stags dominated small antlered males; antlered does were superior to antlerless females, and adult females dominated yearlings.

The establishment of hierarchies should depend on the frequency of reinforcement. Reinforcement would depend on the frequency of interactions, which should be a function of animal numbers and space considerations. If caribou were placed along a continuum from individual territorial to completely socially ranked, I believe they would be near the social hierarchy end.

Literature Cited

Dice, L. R. 1943. The biotic provinces of North America. University of Michigan Press, Ann Arbor, Michigan. 78 pp.

Espmark, Y. 1964a. Rutting behavior in reindeer (*Rangifer tarandus* L.) Animal Behavior 12: 159–163.

Espmark, Y. 1964b. Studies in dominance – subordination relationship in a group of semi-domestic reindeer (*Rangifer tarandus* L.). Animal Behavior 12: 420–426.

Lent, P. C. 1965. Rutting behavior in a barren-ground caribou population. Animal Behavior 13: 259–264.

Lent, P. C. 1966. Calving and related social behavior in barren-ground caribou. Zeitschrift für Tierpsychologie 23: 601–657.

Moisan, G. 1955. The caribou of Gaspé. A preliminary study of range conditions and herd status. M.Sc. thesis, Cornell University, Ithaca, New York. 60 pp.

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Fishes Stranded During Extreme Low Tides in Minas Basin, Nova Scotia

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Bleakney, J. S. and D. E. McAllister. 1973. Fishes stranded during extreme low tides in Minas Basin, Nova Scotia. Canadian Field-Naturalist 87: 371-376.

Abstract. Twenty-one species of fishes caught in Minas Basin during extreme low-water tides included five new records: *Enchelyopus cimbrius, Myoxocephalus scorpius, Cyclopterus lumpus, Liparis atlanticus,* and *Lophius americanus.* Thirty-six species have now been found in this area.

Introduction

The greatest tidal range in the world occurs in the Minas Basin, Nova Scotia, but it is usually the height of the tides that is emphasized in the literature. The extreme lows are equally spectacular, but are seldom observed by biologists, as the majority of such tides center around March and October when field work is minimized. Because of the gradual slope of the shore in the Minas Basin (Figures 1 and 2), the maximal Extreme Low Water Springs (E.L.W.S.) expose additional square miles of sublittoral habitat for periods of usually less than 30 minutes. These E.L.W.S. present the intrepid field biologist with the unique opportunity of an evening's stroll over the sea bed of Minas Basin. The majority of such tides in Minas Basin occur between the hours of 6 and 9, either in the morning or evening.

Collecting

During such occasional extreme tides between 1966 and 1972, 21 species of fishes (Table 1) were collected by hand from the floor of the Minas Basin off Kingsport, Kings County, at a site with high-water depths of approximately 48 feet. This area (E in Figure 3) is about 6/10 of a mile from strand line. Above the low-tide limits, the shore is a relatively smooth sloping expanse of sand and mud, with outcroppings of sandstone over the upper shore, and areas of scattered rocks common to the lower shore (Figure 3). The latter are carried by ice movement from other parts of the Basin and from rock fill in the many derelict wharves (Figure 4).

The field technique consisted simply of arriving about one hour before low tide and following the receding tide, searching the pools as they become exposed. The fast-flowing ebb current is turbid and also creates ripples making it difficult to see, however once the tide has receded from the pools the surface becomes calm and suspended matter quickly settles out. On the flood tide, the pools were worked over again; by then they contained tracks and trails in the fresh silt revealing the presence of forms not otherwise visible or suspected.

Extreme Low Water Spring tides that are less than 1 foot above Datum on Tide and Current Tables for Saint John, New Brunswick, present the one possibility of studying this benthic community *in situ* (Bleakney 1972). It is not an area that can otherwise be examined visually because severe turbidity discounts the possibility of using SCUBA or underwater TV. It is unlikely that dredging would reveal the pattern of depressions and elevations which characterize this sublittoral region creating a peculiar landscape of innumerable pools and troughs mostly 3 to 6 feet long (Figure 2). Most pools are 1 to 4 inches deep with a bottom composition of fine silt. It would be difficult effectively to seine this habitat because each depression is surrounded by a jagged sand ridge of firmly cemented worm tubes constructed by the polychaete *Sabellaria*

TABLE 1. — Fishes of Minas Basin, Nova Scotia

Species		Huntsman (1922)	Bousfield & Leim (1960)	Leim & Scott (1966)	Other records†	Number of specimens, present study
Sea lamprey	*Petromyzon marinus*			+		
Thresher shark	*Alopias vulpinus*	+	+	+		
+White shark	*Carcharodon carcharias*				1	
Little skate	*Raja erinacea*	+	+			6
Barndoor skate	*Raja laevis*		+	+		
Winter skate	*Raja ocellata*		+			1
Atlantic sturgeon	*Acipenser oxyrhynchus*		+	+		
Gaspereau	*Alosa pseudoharengus*		+		1	
American shad	*Alosa sapidissima*	+	+	+		1
Atlantic menhaden	*Brevoortia tyrannus*				1	
Atlantic herring	*Clupea harengus*		+		1	
Atlantic salmon	*Salmo salar*	+	+			
Rainbow smelt	*Osmerus mordax*	+	+		1	1
American eel	*Anguilla rostrata*		+			
#Fourbeard rockling	*Enchelyopus cimbrius*					1
Atlantic cod	*Gadus morhua*	+	+			
Atlantic tomcod	*Microgadus tomcod*	+	+		25	17
White hake	*Urophycis tenuis*	+	+			2
*Silver hake	*Merluccius bilinearis*		+			2
Atlantic silverside	*Menidia menidia*		+	+		12
Mummichug	*Fundulus heteroclitus*		+			
Northern pipefish	*Syngnathus fuscus*		+			6
Smooth flounder	*Liopsetta putnami*		+		3	7
Winter flounder	*Pseudopleuronectes americanus*	+	+		1	18
Windowpane	*Scophthalmus aquosus*		+			2
Striped bass	*Morone saxatilis*	+	+	+		
Butterfish	*Peprilis triacanthus*		+			
Sea raven	*Hemitripterus americanus*	+	+	+		10
Grubby	*Myoxocephalus aeneus*	+	+	+		5
#Shorthorn sculpin	*Myoxocephalus scorpius*					1
#Lumpfish	*Cyclopterus lumpus*					1
#Atlantic seasnail	*Liparis atlanticus*					6
Ocean pout	*Macrozoarces americanus*	+	+			4
Rock gunnell	*Pholis gunnellus*	+	+	+		7
Northern sand lance	*Ammodytes dubius*		+			
#Goosefish	*Lophius americanus* (Observed)					1
Total species	36					

†From a 1959 National Museum seine haul at Evangeline Beach except for Atlantic menhaden which is a Royal Ontario Museum specimen from Kingsport wharf.
#New records.
*Picked up dead.
+Netted off Burntcoat Head, Cobequid Bay.

vulgaris (Verrill), a species not noted by Bousfield and Leim (1960) as occurring in the Minas Basin. The diameter of these tubes is only in the order of 2 mm but they have been built one upon the other to form an intertwining layer, as thick as 5 inches, which is easily crushed underfoot. Rocks are sparse in this "Crunchy Zone," but such items as a wooden barrel, a wharf piling, a tree trunk, and a rectangular stone block have been observed and each

FIGURE 1. Kingsport shore, Minas Basin, from a position at the edge of the *Sabellaria vulgaris* tube-worm zone, approximately 48 feet below high-water level, which is evident at the undercut base of the sandstone cliffs. Note large boulder-like sandstone outcrops on upper beach, scattered rocks across lower beach, and foreground of sand grains cemented into a carpet of worm tubes. Footprints near basket demonstrate the "crunchy" aspect of this zone, which is exposed only briefly by low water spring tides. Photo was taken 23 June 1971, (2.1′ tide), but trenches created by moving ice blocks in February and March 1971 are still evident.

possessed a rich epifauna of barnacles, porifera, hydrozoans, ectoprocts, and nudibranchs. The Atlantic sea snail, *Liparis atlanticus,* was usually found associated with such solid objects.

The Fishes

Table 1 lists the fish species collected and now deposited at the National Museum of Natural Sciences, Ottawa, as well as other museum and literature records reported from Minas Basin by Huntsman (1922), Bousfield and Leim (1960), Leim and Scott (1966), and Case (1968.) It includes those specimens collected or recorded on 14 of 24 field trips to Kingsport by the senior author, usually accompanied by students; and one collection made by the second author in August 1959. Smaller specimens were invariably in the pools, but larger fish were more often conspicuously perched upon the exposed *Sabellaria* ridges. No attempt was made to collect the larger specimens of skates, flounders, sea ravens, lumpfish, and goosefish on each trip as the prime interest was invertebrates and the fish collections were deliberately limited to only a few specimens of each species. The composition of the ichthyological strandings of these E.L.W.S. was always a surprise, and no two trips ever produced quite the same faunal list. Often one species dominated in the immediate limited acreage of the search group. There were skate nights, sea-raven mornings, species-diversity evenings, and on 5 October 1971 the unique appearance of dozens of the northern pipefish *Sygnathus fuscus* in a Basin where *Zostera* is unknown.

FIGURE 2. Sublittoral fringe at Kingsport showing acres of ridges of sand cemented together by the polychaeta *Sabella ia vulgaris* and shallow pools between. Twenty-one species of fishes have been found stranded in this habitat du:ing maximal E.L.W.S. There is a characteristic paucity of rocks in this area. (26 April 1967; —0.3′ tide.)

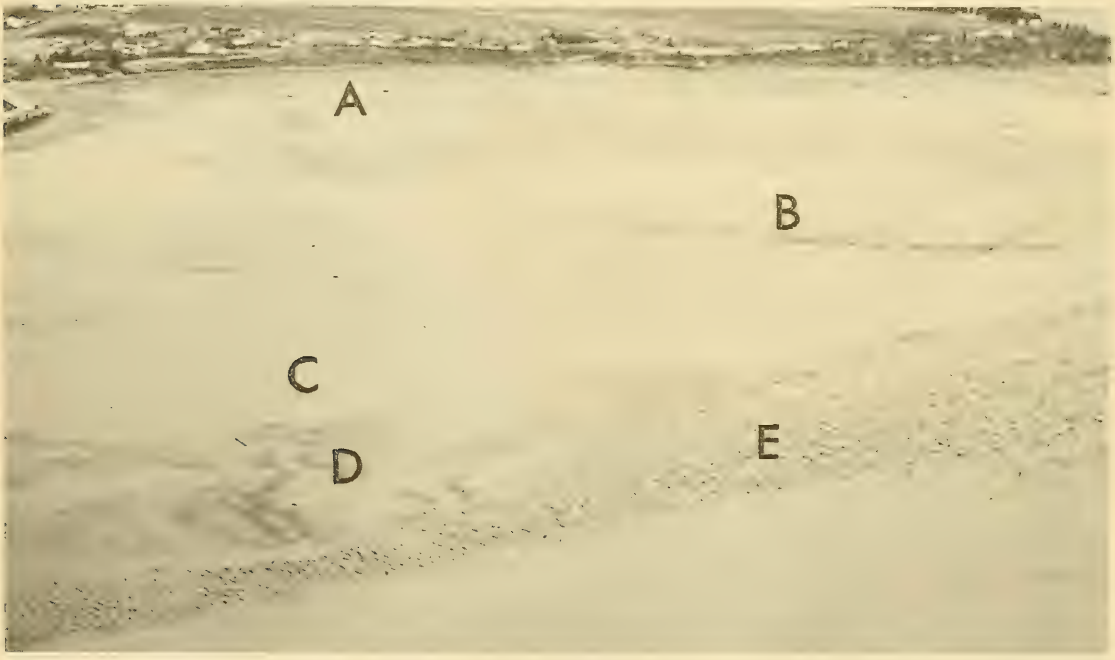

FIGURE 3. Air photo of beach area immediately east of Kingsport wharf, which is in upper left corner. Black objects on upper beach A, are sandstone outcroppings. The dark diagonal area B is strewn with rocks. Area C is muddy, D is sandy, and E consists of sand cemented together by the polychaeta *Sabellaria vulgaris*. (27 April 1971; 0.7′ tide.)

FIGURE 4. Upper *Sabellaria* tube-worm zone showing ice-scoured trenches running diagonally from incoming tide. Stones in foreground and in centerground beside the basket (shown again in Figure 2) were transported by blocks of ice. (23 June 1971; 2.1′ tide.)

Discussion

Twenty-one species were collected or observed on the Minas Basin tide flats. Benthic or benthopelagic species predominated and *Enchelyopus cimbrius, Myoxocephalus scorpius, Cyclopterus lumpus, Liparis atlanticus,* and *Lophius americanus* had not previously been reported from Minas Basin.

The reduced salinity of the basin, 29.0 to 30.5 reported by Bousfield and Leim (1960) and the discharge of the Avon and Schubenacadie watersheds is reflected in euryhalinity of one third of the species. These are either anadromous, catadromous, or brackish-water tolerants.

Species stranded are deprived of the liquid medium upon which their vertical equilibrium depends and thus the presence of benthic fishes with flattened bodies, such as skates and flounders, and those with large broad-base heads like the sculpins, liparids, and goosefishes is to be expected.

The turbidity fostered by extreme tides also presents potential difficulties, for Robins (1957) reported that much of the mortality in shore fishes during storms can be attributed to wave-disturbed sediments which clog the gills. Whether there has been selection for improved filtering mechanisms in Minas Basin populations has yet to be determined. Tomcod, the commonest Basin species, hake, and rockling are provided on the chin and filaments on the pelvic fin with barbels which bear taste buds (Herrick 1903), enabling these species to find food even though turbidity prevents visual prey location. Most of these species thus have one or more adaptations fitting them to live in this extensive Minas Basin intertidal zone with its dynamic semi-diurnal tides of nearly 50-foot amplitude.

Acknowledgments

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Literature Cited

Bleakney, J. S. 1972. Ecological implications of annual variation in tidal extremes. Ecology 53(5): 933–938.

Bousfield, E. L. and **A. H. Leim.** 1960. The fauna of Minas Basin and Minas Channel. National Museums of Canada Bulletin 166: 1–30.

Case, Gerard R. 1968. Inland shark occurrence. Underwater Naturalist 5(1): 20–21, 37.

Herrick, C. J. 1903. The organ and sense of taste in fishes. United States Fish Commission Bulletin 22: 237–271.

Huntsman, A. G. 1922. The fishes of the Bay of Fundy. Contributions to Canadian Biology for 1921. pp. 51–72.

Leim, A. H. and **W. B. Scott.** 1966. Fishes of the Atlantic Coast of Canada. Fisheries Research Board of Canada Bulletin 155: 1–485.

Robins, C. R. 1957. Effects of storms on the shallow water fish fauna of southern Florida with new records of fishes from Florida. Bulletin of Marine Science of the Gulf and Caribbean 7(3): 266–275.

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Avifauna of the Drumheller Area, Alberta

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Abstract. The unique avifauna of the Drumheller area is discussed in relation to physiography, vegetation, and land use, and the passerine component is analyzed in biogeographical terms. Two hundred and thirty-two species are included in an annotated list. Seven records represent extensions beyond the presently defined breeding ranges.

Introduction

The area around Drumheller, located in the Red Deer River Valley 60 miles east-northeast of Calgary in the Mixed Grassland vegetation zone of southern Alberta, is probably best known for its rugged badlands which have been created by intensive fluvial erosion. The region is interesting because of biological and topographical features which contrast strikingly with the surrounding cultivated plain.

Apart from fragmentary accounts by Taverner (1919), Salt (1938, 1939, 1950, 1958), Salt and Wilk (1966), and Owens (1971), little is known of the avifauna of the Drumheller area, particularly in relation to physiography, vegetation, and land use. The purpose of this paper is to provide an up-to-date account of the avifauna and its distribution in relation to habitat types. Extensive field work was conducted by the authors during 1970, 1971, and 1972, although sporadic studies have been carried out since 1965.

Description of the Study Area

The study area includes townships 24 to 30 and ranges 16 to 22 inclusively, west of the fourth meridian (Figure 1). Most of the study area is a relatively flat plain dotted with numerous sloughs and a few lakes. South of the Red Deer River, the land is almost totally cultivated. To the north of the river and in the Crawling Valley area the land is utilized for grazing. Three major streams are present in the area, the Red Deer River, Rosebud River, and Kneehills Creek. Numerous coulees transect the plain, emptying into the major stream courses. Extensive badland formations are found in Horseshoe Canyon and areas along the Red Deer River. In the northeastern corner of the study area, the Hand Hills rise approximately 900 feet above the surrounding plain. Less prominent are the Wintering Hills west of Dorothy. Drumheller (population 5,240) is the only city located in the study area but there are several small towns and the area is transected by numerous roads.

Methodology

Most of the information used in this report comes directly from field observations made by the authors over a seven-year period. All statements made in the Avian Habitat section were based on the authors' personal observations. However, data on file with the Calgary Field-Naturalists' Society and Professor W. R. Salt's records were used in the Annotated List of the Birds.

The most intensive field studies were undertaken in 1970, 1971, and 1972. For most of May and June in 1970, Cleve Wershler assisted in a detailed study which was concerned with the effects of agriculture on grassland birds in the Hand Hills area (Owens 1971). Field research was carried out by the authors almost every weekend from April 1971 to October 1972. In addition to visiting regularly certain

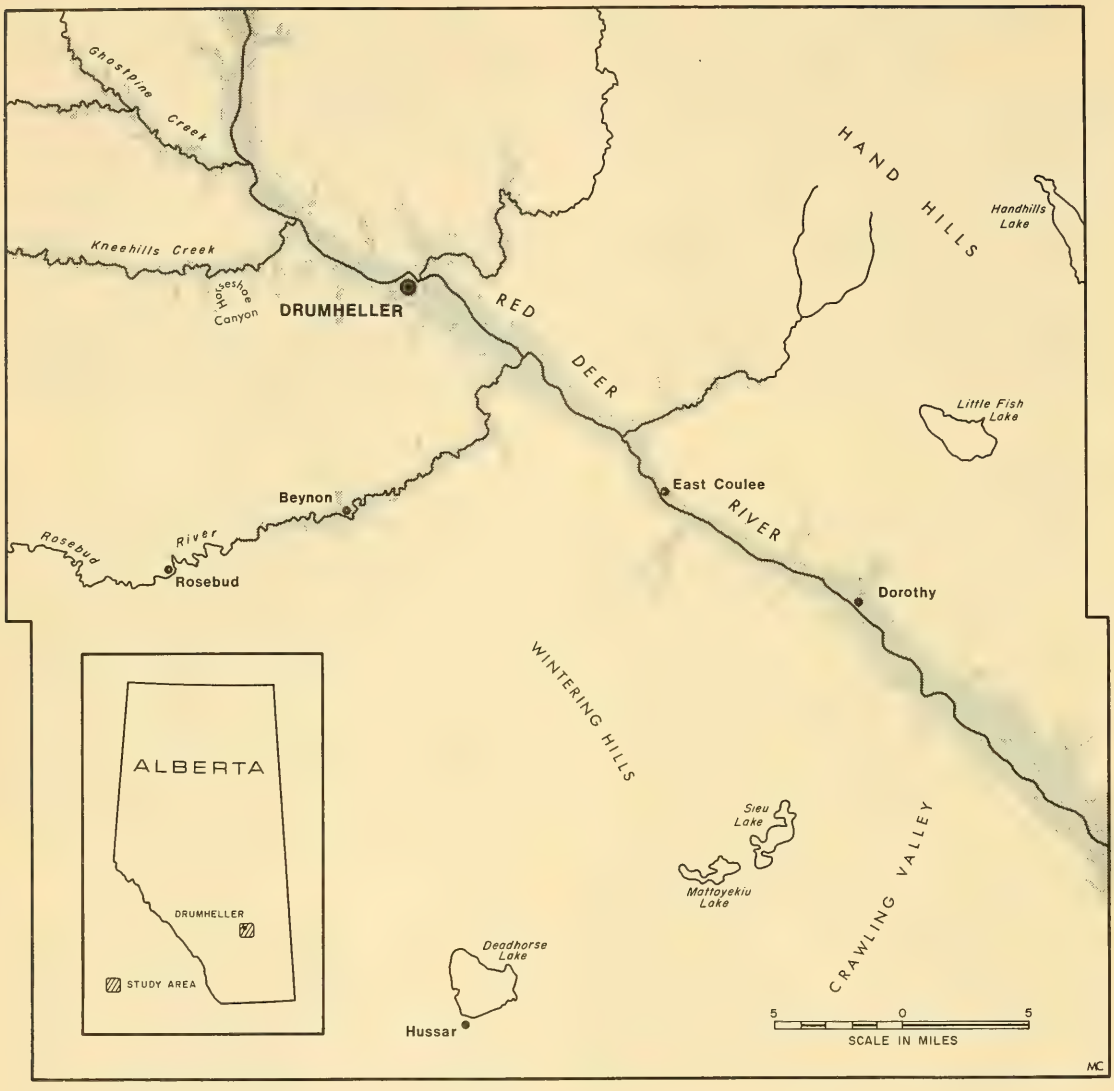

FIGURE 1. Map of the study area. The shaded area represents the major valleys and coulees.

representative habitats, considerable random sampling was done to ensure a fairly thorough coverage.

Avian Habitats

A wide spectrum of habitats is present in the study area, from barren slopes, sageland, and grassland to dense thickets, poplar and spruce woods. This diversity can be correlated with the microenvironments created by the wide variety of land forms. There are also numerous aquatic and man-influenced habitats. Vast continuous cultivated and grazed areas dominate the relatively flat plains and contrast with the discontinuous and diverse habitats found on the two major hill formations and in the valleys and coulees associated with the major streams. A general description of the habitats is provided, listing the dominant plant and characteristic bird species. A more detailed description

FIGURE 2. Badlands at Horseshoe Canyon. Habitat for Rock Wrens and Lark Sparrows.

FIGURE 3. River terrace at the junction of the Red Deer River and Kneehills Creek. Few birds use the sageflat in the foreground. The tall shrubs and riverine poplar woods in the background support a large and varied avifauna.

of the vegetation of the coulees can be found in Pinel and Wallis (1972b). Geological analyses are provided by Craig (1957) and Irish (1967, 1970).

A. Badland Habitat

This type of habitat (Figure 2) is characterized by rapidly eroding slopes having a paucity of vegetation dominated by sagebrush (*Arte-*

misia spp.). It occurs on coulee and valley sides with a southerly aspect and on the periphery of buttes. Characteristic birds nesting in the badlands include Mourning Dove, Say's Phoebe, Rock Wren, Mountain Bluebird, and Lark Sparrow.

Mountain Bluebirds and Rock Wrens make extensive use of small holes in the badland slopes. Say's Phoebes nest in crevices in sandstone strata and small caves. Occasionally, Mourning Doves nest on ledges in this habitat.

Lark Sparrows are often found singing and foraging on badland formations but appear to confine their nesting activities to the sagebrush areas at the base of these features.

Although not restricted to badland habitats, Canada Geese, Ferruginous Hawks, Cliff Swallows, and Prairie Falcons nest on steep southerly-facing slopes. Canada Geese often use old Ferruginous Hawk nests, although they sometimes utilize ledges and tops of cliffs.

Along the Red Deer River Valley, sage flats occupy the higher parts of river terraces (Figure 3). Despite the extent of this habitat, our observations indicate that few species are found here. Although we have no definite evidence, we suspect that Lark Sparrows and possibly Western Meadowlarks and Vesper Sparrows nest in this habitat.

B. Grassland Habitats

In general, native mixed and fescue grasslands exist only in the Hand Hills, Wintering Hills, and isolated portions of the coulee systems. In other areas, a short-grass "grazing climax" exists. Formerly, most of the area now occupied by cultivated land was native mixed grassland as described by Coupland (1950). Long-billed Curlews, Horned Larks, and Chestnut-collared Longspurs favor extensive areas of short-grass which are created by the grazing of livestock and, in the Hand Hills, by the mowing of the fescue grassland.

Extensive field work conducted in the relatively undisturbed fescue grasslands on the south slopes of the Hand Hills in the vicinity of Little Fish Lake shows four species to be characteristic and somewhat restricted to this habitat (Figure 4). Baird's Sparrow and Sprague's Pipit nest in good numbers throughout this habitat. Upland Plovers are locally distributed, apparently in loose colonies, in low-lying areas. Sharp-tailed Grouse also range throughout this grassland with several leks existing on higher ground around Little Fish Lake. For more information on the effects of agriculture on passerine birds in this area, consult Owens (1971).

Birds that show no apparent preference for any specific grassland type include Marbled Godwit, Willet, Short-eared Owl, and Western Meadowlark. Vesper Sparrows are found frequently in grassy areas with scattered shrubs, and along grassy fencelines. Savannah Sparrows are found throughout tall-grass areas but show a decided preference for dry grassy slough bottoms and margins of sloughs. Dabbling ducks (*Anas* spp.), although not restricted to grasslands, prefer to nest in taller grassland areas.

C. Man-Influenced Habitats

Man-influenced habitats are those which have been drastically altered by man's activities. No species nests exclusively in the extensive cultivated areas, although Mallards, Pintails, Killdeers, Long-billed Curlews, Willets, Short-eared Owls, and Horned Larks do nest in this habitat.

Caragana, poplars, white spruce, lilac, and Manitoba maple are characteristic of windbreaks in the area. Species most frequently nesting in this habitat include the Swainson's Hawk, Mourning Dove, Great Horned Owl, Yellow-shafted Flicker, Eastern Kingbird, House Wren, Robin, Cedar Waxwing, Starling, Yellow Warbler, House Sparrow, Baltimore Oriole, Brewer's Blackbird, and American Goldfinch.

The following species utilize man-made structures (buildings, bridges, culverts, deserted machinery, birdhouses) to varying extents: Rock Dove, Say's Phoebe, Barn Swallow, Cliff Swallow, House Wren, Robin, Mountain Bluebird, Starling, and House Sparrow.

D. Shrub Habitats

Low shrub thickets, which are dominated by buckbrush (*Symphoricarpos occidentalis*) and rose (*Rosa* spp.), are found in a variety of loca-

FIGURE 4. A vanishing habitat in western North America — fescue grassland near Little Fish Lake. Aspen clones are visible in the background.

FIGURE 5. Extensive white spruce – aspen woodland on a northeast-facing coulee slope north of Horseshoe Canyon.

tions, from low-lying grasslands and creek bottoms to the edges of woodlands. The Clay-colored Sparrow is a characteristic bird of this habitat. Other birds that nest here include the dabbling ducks, Short-eared Owl, Marsh Hawk, and Brewer's Blackbird.

Saskatoon (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), pin cherry (*Prunus pensylvanica*), thorny buffaloberry (*Shepherdia argentea*), and willows (*Salix* spp.) form tall thickets along streams (Figure 3), and in depressions on slopes and on the periphery of wooded areas and sloughs. The most abundant nesting birds found here include Black-billed Magpie, Eastern Kingbird, Cedar Waxwing, Yellow Warbler, and American Goldfinch. Species which appear to be confined to tall shrub thickets in the coulees and valleys are the Brown Thrasher, Catbird, and Rufous-sided Towhee. MacGillivray's Warbler is locally distributed in these thickets in proximity to spruce or mixed woods.

E. Aspen and Spruce Woodland

Along the coulees on north- and east-facing slopes, aspen (*Populus tremuloides*) and white spruce (*Picea glauca*) woods predominate, with varying degrees of admixture (Figure 5). Extensive aspen stands also exist on the north-facing slopes of the Wintering Hills and at higher elevations in the Hand Hills.

Characteristic inhabitants of the aspen woodlands are the Least Flycatcher, Red-eyed Vireo, and Orange-crowned Warbler. In mixed woods, the characteristic summer residents include Red-tailed Hawk, Great Horned Owl, Blue Jay, Black-capped Chickadee, Robin, and Chipping Sparrow. Flicker hybrids are more common in this habitat than in the riverine community.

Only two species are known to nest in stands of pure spruce. These are the Red-tailed Hawk and Slate-colored Junco. However, in the winter a greater number of species frequent this habitat, including Great Horned Owl, Hairy Woodpecker, Downy Woodpecker, Blue Jay, Black-billed Magpie, Black-capped Chickadee, Red-breasted Nuthatch, Brown Creeper, Golden-crowned Kinglet, Pine Grosbeak, White-winged and Red Crossbills.

F. Riverine Habitat

In the valley bottoms of the Red Deer River, Rosebud River, and Kneehills Creek, stands of poplars (*Populus balsamifera* and *P. sargentii*)

occur, the most extensive being present along the Red Deer River (Figure 3). Red osier dogwood (*Cornus stolonifera*) and rose (*Rosa* spp.) are the dominant shrubs of the thick understory.

Characteristic nesting birds of this habitat are the Sparrow Hawk, Yellow-shafted Flicker, Western Kingbird, Least Flycatcher, Western Wood Pewee, Black-capped Chickadee, House Wren, Warbling Vireo, and Baltimore Oriole. Hybridization between Yellow-shafted and Red-shafted Flickers occurs in the area (Salt and Wilk 1966), although the latter species is scarce. Other species commonly observed in this habitat include the Red-tailed Hawk, Great Horned Owl, Mourning Dove, Eastern Kingbird, Catbird, Brown Thrasher, Robin, and Yellow Warbler.

In the low-lying areas immediately adjacent the streams, dense belts of willows are present. These are frequented by Eastern Kingbirds, Yellowthroats, and Song Sparrows. The Yellow-breasted Chat appears to favor the more extensive areas of willow and tall shrub thickets along the major streams.

G. Aquatic Habitats

Few birds nest on sloughs which have sparse emergent vegetation, but this habitat acts as a food source for dabbling ducks and numerous species of shorebirds, both resident and migrant. Sloughs with emergent vegetation may be dominated by bulrushes (*Scirpus* spp.), sedges (*Carex* spp.), cattails (*Typha latifolia*), and knotweeds (*Polygonum* spp.), or combinations of the above (Figure 6). These sloughs support the following nesting birds: Eared Grebe, Horned Grebe, Pied-billed Grebe, Redhead, Canvasback, Lesser Scaup, Ruddy Duck, Marsh Hawk, Sora, American Coot, Wilson's Phalarope, Black Tern, Yellow-headed Blackbird, and Red-winged Blackbird.

Handhills and Little Fish Lakes are deep-water lakes, and their levels do not fluctuate appreciably. Other lakes (Mattoyekiu, Sieu, and Deadhorse) are present but they are shallow and intermittent. Apart from Mattoyekiu Lake, which is very similar to a slough, few birds nest on the lakes, but they are important areas for migrating waterfowl and shorebirds.

American Avocet is a characteristic nesting species of sparsely vegetated slough and lake margins.

Numerous cutbanks along the streams provide suitable nesting sites for the Belted Kingfisher, Bank Swallow, and Rough-winged Swallow. Spotted Sandpipers are common along the major streams. The Red Deer River is frequented by large numbers of molting Canada Geese.

Annotated List of the Birds

Two hundred and thirty-two species are recorded in this catalogue. Of this number, 89 species (indicated by *) have substantiated nesting data (e.g. an active nest or flightless young), and another 20 (indicated by †) have nested in the area (i.e. all evidence indicates this) although no concrete data have been found to date. Nomenclature is according to the *Check-list of North American Birds,* 5th edition (American Ornithologists' Union 1957). The extensive use of dates and localities has been avoided for most species because of the large amount of data available. In a few cases, where a species is known from only a few records, dates and locations are provided. For most species, favored habitat, abundance, and seasonal status are listed. The abundance rating (rare, scarce, uncommon, fairly common, common) refers to relative frequency except where the information is other than the authors' personal data. It is based on subjective evaluations by the authors in the field, the available habitat being kept in mind.

COMMON LOON. *Gavia immer.* Observed as a migrant at Little Fish Lake in late April and early May of 1970 and 1971. Eight birds were seen on April 27, 1970. On May 31, 1970, a pair was observed in "courtship flight" over grassland adjacent to Little Fish Lake, which possibly indicates nesting in view of the date. Seen in the fall on Severn Reservoir south of Rosebud.

RED-NECKED GREBE. *Podiceps grisegena.* Scarce spring migrant, seen at Little Fish Lake in late April and early May, 1970, and on a deep slough near Beynon on April 26, 1972.

FIGURE 6. Slough with extensive *Scirpus* beds — a very productive habitat in contrast to the surrounding cultivated plain.

FIGURE 7. Rosebud River near Beynon, looking northeast. A variety of habitats are visible: spruce woods, badlands, grasslands, and along the river, shrubs and poplar woods. Part of an extensive aspen stand can be seen through the spruce trees in the foreground. Cultivated land appears on the horizon.

*HORNED GREBE. *Podiceps auritus.* Common summer resident on sloughs throughout the area.

*EARED GREBE. *Podiceps caspicus.* Fairly common but local summer resident, nesting in colonies on the larger sloughs.

WESTERN GREBE. *Aechmophorus occidentalis.* Common migrant at Little Fish Lake. About 300 were observed on May 6, 1970, and a few spent the summer there, although no nests were found. Smaller numbers have been seen at Deadhorse Lake during their migration.

*PIED-BILLED GREBE. *Podilymbus podiceps.* Uncommon and local summer resident. The more heavily-vegetated sloughs appear to be a favored habitat.

WHITE PELICAN. *Pelecanus erythrorhynchos.* Summer visitor at Little Fish Lake. Known from one set of records in late June and early July of 1970 (Smith and Wershler 1971). This lengthy stay (several weeks) indicates the presence of an adequate food supply; subsequent records, therefore, may be expected.

DOUBLE-CRESTED CORMORANT. *Phalacrocorax auritus.* One bird was seen at Little Fish Lake in June 1970.

GREAT BLUE HERON. *Ardea herodias.* Regular summer visitor, most often seen during July and August.

AMERICAN BITTERN. *Botaurus lentiginosus.* One bird was seen on July 31, 1971, 4 miles northeast of Standard. It is possible that this species nests in the area; little suitable habitat exists, however.

WHITE-FACED IBIS. *Plegadis chihi.* There is a sight record of one bird near Rosebud, June 18, 1941 (Salt, personal communication).

WHISTLING SWAN. *Olor columbianus.* Common migrant in April and October throughout the area.

*TRUMPETER SWAN. *Olor buccinator.* There are two records for the area, both from Mattoyekiu Lake, one on June 16, 1972, when one adult was observed, the other in June 1967 when two adults and three young were seen. This is one of the very few nesting records in southern Alberta outside of the Cypress Hills.

*CANADA GOOSE. *Branta canadensis.* Common migrant but uncommon summer resident. Canada Geese have been found nesting on the larger lakes and in Ferruginous Hawk nests on cliffs along the major streams.

WHITE-FRONTED GOOSE. *Anser albifrons.* Scarce migrant, recorded during September and October, only in the easternmost portions of the study area at the larger lakes.

SNOW GOOSE. *Chen hyperborea.* Common migrant, during April and October, often occurring in very large flocks. The blue phase of this species has been observed twice in the area.

ROSS' GOOSE. *Chen rossii.* Regular migrant, usually seen in small numbers accompanying larger flocks of Snow Geese.

*MALLARD. *Anas platyrhynchos.* Common summer resident, nesting throughout the area.

*GADWALL. *Anas strepera.* Fairly common summer resident.

*PINTAIL. *Anas acuta.* Common summer resident throughout the area.

†GREEN-WINGED TEAL. *Anas carolinensis.* Common migrant. A few resident birds are present during the nesting season.

*BLUE-WINGED TEAL. *Anas discors.* Common summer resident, nesting throughout the area.

CINNAMON TEAL. *Anas cyanoptera.* Known from records during June 1970 and May 1972, but it is probably more common than these records indicate and it may nest here.

*AMERICAN WIDGEON. *Mareca americana.* Common summer resident throughout the area.

*SHOVELER. *Spatula clypeata.* Fairly common summer resident.

*REDHEAD. *Aythya americana.* Uncommon summer resident on deeper sloughs.

RING-NECKED DUCK. *Aythya collaris.* Scarce migrant. However, in 1972 a male was seen throughout the nesting season and a pair and two pairs were recorded in late May and early August, respectively.

*CANVASBACK. *Aythya valisineria.* Uncommon summer resident on the deeper sloughs but more frequently observed than Redheads.

*LESSER SCAUP. *Aythya affinis.* Common summer resident on the lakes and deeper sloughs.

COMMON GOLDENEYE. *Bucephala clangula.* Fairly common spring migrant during April and early May, less common in the fall. Small numbers occasionally winter on open water on the Red Deer River near Drumheller (Salt and Wilk 1966).

BARROW'S GOLDENEYE *Bucephala islandica.* Irregular spring migrant. Two records during April and May 1971.

BUFFLEHEAD. *Bucephala albeola.* Fairly common spring migrant during April and early May, less common in the fall. Of interest is an observation of approximately 50 birds in July 1972 on Sieu Lake.

WHITE-WINGED SCOTER. *Melanitta deglandi.* Uncommon migrant and summer visitor on the deeper bodies of water.

*RUDDY DUCK. *Oxyura jamaicensis.* Fairly common summer resident on deeper sloughs.

COMMON MERGANSER. *Mergus merganser.* Uncommon spring migrant on Little Fish Lake in late April and early May.

RED-BREASTED MERGANSER. *Mergus serrator.* Fairly common spring migrant on Little Fish Lake in late April and early May.

TURKEY VULTURE. *Cathartes aura.* Former summer resident (visitor?) (Taverner 1919). There is a recent

record of one seen on May 17, 1958, near East Coulee (Alberta Bird Report 1958).

*GOSHAWK. *Accipiter gentilis.* Scarce winter visitor. There is an old breeding record (Taverner 1919) at East Coulee.

[1]SHARP-SHINNED HAWK. *Accipiter striatus.* Scarce migrant. Known from a record of one bird seen April 10, 1971, at East Coulee.

[1]COOPER'S HAWK. *Accipiter cooperii.* Scarce migrant. Single birds were recorded September 21, 1957, at Beynon (Alberta Bird Report 1957) and September 5, 1965, near Drumheller. An immature was found dead by M.A. Biggs March 22, 1971, at Beynon. Two were seen flying north May 5, 1970, near Drumheller.

*RED-TAILED HAWK. *Buteo jamaicensis.* Fairly common summer resident in wooded areas. However, there is one record of cliff-nesting for this species (Pinel and Wallis 1972a).

BROAD-WINGED HAWK. *Buteo platypterus.* Scarce migrant. One bird was seen on August 13, 1972, flying over the Wintering Hills. W.R. Salt also has records of this species in the area (Salt, personal communication).

*SWAINSON'S HAWK. *Buteo swainsoni.* Common summer resident, preferring isolated pockets of trees or willows for nesting sites. This species is not known to nest in the coulees and river valleys.

ROUGH-LEGGED HAWK. *Buteo lagopus.* Common migrant during March, April, September, and October, occasionally wintering in the area.

*FERRUGINOUS HAWK. *Buteo regalis.* Fairly common summer resident in the coulee systems and river valleys where it nests on the eroded slopes.

*GOLDEN EAGLE. *Aquila chrysaetos.* Rare summer resident and uncommon spring migrant in late March and early April. A pair nested in a secluded coulee along the Red Deer River in 1971 and photographic proof was secured (Salt, personal communication). This species has wintered in the area.

BALD EAGLE. *Haliaeetus leucocephalus.* Uncommon migrant during March and April.

*MARSH HAWK. *Circus cyaneus.* Common summer resident, nesting most frequently in low shrub thickets.
OSPREY. *Pandion haliaetus.* Rare and irregular migrant.

GYRFALCON. *Falco rusticolus.* Rare winter visitor.

[1]Very suitable nesting habitat exists for these accipiters in the mixed woods of the coulee systems. An unidentified accipiter (probably a Cooper's Hawk) was seen on May 28, 1972, north of Beynon.

*PRAIRIE FALCON. *Falco mexicanus.* Fairly common summer resident, occasionally wintering.

*PEREGRINE FALCON. *Falco peregrinus.* Formerly nested in the area (Salt and Wilk 1966), now only a rare migrant.

*PIGEON HAWK. *Falco columbarius.* Scarce summer resident, occasionally wintering in the area.

*SPARROW HAWK. *Falco sparverius.* Common summer resident, especially in the tall poplars along the major streams.

†RUFFED GROUSE. *Bonasa umbellus.* This species was observed by W.R. Salt on September 6 and 27, 1942, near Munson, and near Dorothy around 1943–1944. On May 26, 1907, C. Garrett collected eight fresh eggs from a nest found amongst willows on a river flat near Carbon, which lies 3 miles west of the study area on Kneehills Creek. One was seen "downstream from Drumheller" in 1917 (Taverner 1919).

GREATER PRAIRIE CHICKEN. *Tympanuchus cupido.* The most recent record of this species is by W.R. Salt, north of the Hand Hills in 1925.

†SHARP-TAILED GROUSE. *Pedioecetes phasianellus.* Fairly common resident where fescue grassland occurs, especially in the Hand Hills and Wintering Hills.

*RING-NECKED PHEASANT. *Phasianus colchicus.* Fairly common resident.

*CHUKAR. *Alectoris graeca.* This game bird was introduced to Horseshoe Canyon in April of 1966. An adult with a brood was seen at Horseshoe Canyon (Sadler, personal communication). As in other attempted introductions in Alberta, it did not become established in the area.

*GRAY PARTRIDGE. *Perdix perdix.* Fairly common resident.

SANDHILL CRANE. *Grus canadensis.* Regular migrant, travelling in small flocks of usually 5–25 birds.

†SORA. *Porzana carolina.* Uncommon summer resident in sloughs with dense emergent vegetation (especially *Carex* spp.).

*AMERICAN COOT. *Fulica americana.* Common summer resident, on sloughs throughout the area.

SEMIPALMATED PLOVER. *Charadrius semipalmatus.* Uncommon migrant during late May and August on the margins of the larger bodies of water. Loose flocks of up to 10 birds have been observed at Deadhorse Lake during fall migration.

*KILLDEER. *Charadrius vociferus.* Common summer resident, utilizing a wide variety of open non-aquatic habitats.

AMERICAN GOLDEN PLOVER. *Pluvialis dominica.* Rare migrant, known from two records of single birds, once on October 28, 1965, and the other in May 1970.

BLACK-BELLIED PLOVER. *Squatarola squatarola.* Uncommon migrant during late May, early June, and August along the larger bodies of water.

†COMMON SNIPE. *Capella gallinago.* Scarce summer resident, favoring sedge meadows.

*LONG-BILLED CURLEW. *Numenius americanus.* Uncommon summer resident on cultivated and uncultivated grassland.

WHIMBREL. *Numenius phaeopus.* Known from a record of two birds, one of which was collected, near Rosebud, May 19, 1941 (Salt, personal communication).

†UPLAND PLOVER. *Bartramia longicauda.* Summer resident. Locally distributed in areas of prime fescue grassland in the Hand Hills.

†SPOTTED SANDPIPER. *Actitis macularia.* Fairly common summer resident, most abundant along the major streams; also found at Little Fish Lake.

SOLITARY SANDPIPER. *Tringa solitaria.* Uncommon fall migrant during August and September.

*WILLET. *Catoptrophorus semipalmatus.* Fairly common summer resident, nesting in both cultivated and uncultivated fields at varying distances from water.

GREATER YELLOWLEGS. *Totanus melanoleucus.* Uncommon migrant during late April, May, August, and September.

LESSER YELLOWLEGS. *Totanus flavipes.* Common migrant during the latter half of May, and in August and September.

KNOT. *Calidris canutus.* Four migrating birds were observed at Little Fish Lake on May 11, 1970, during a late snowfall.

PECTORAL SANDPIPER. *Erolia melanotos.* Fairly common migrant during May, August, and September. On September 26, 1972, about 600 were observed on Deadhorse Lake in company with about 200 Lesser Yellowlegs and 200 Sanderlings.

BAIRD'S SANDPIPER. *Erolia bairdii.* Fairly common migrant during May and August. This and the previous species show a definite preference, especially noticeable in spring, for vegetated slough margins.

LEAST SANDPIPER. *Erolia minutilla.* Fairly common migrant during May and August.

SHORT-BILLED DOWITCHER. *Limnodromus griseus.* Scarce migrant, usually accompanying Long-billed Dowitchers.

LONG-BILLED DOWITCHER. *Limnodromus scolopaceus.* Fairly common migrant during May, July, August, and September, usually in small flocks.

SEMIPALMATED SANDPIPER. *Ereunetes pusillus.* Common migrant during the latter half of May and August.

*MARBLED GODWIT. *Limosa fedoa.* Fairly common summer resident, nesting in both cultivated and uncultivated grassland.

HUDSONIAN GODWIT. *Limosa haemastica.* Two records of single birds seen on April 27 and May 7, 1970, at Little Fish Lake.

SANDERLING. *Crocethia alba.* Uncommon migrant during late May, early June, August and September but has been observed in large flocks (see Pectoral Sandpiper).

*AMERICAN AVOCET. *Recurvirostra americana.* Common summer resident on the margins of shallow water bodies with little emergent vegetation, most abundant on noticeably alkaline sloughs.

*WILSON'S PHALAROPE. *Steganopus tricolor.* Fairly common summer resident, nesting locally in areas of shallow water with short emergent vegetation.

NORTHERN PHALAROPE. *Lobipes lobatus.* Uncommon spring migrant in May, common fall migrant during August and September.

HERRING GULL. *Larus argentatus.* Recorded only from Little Fish Lake, with peak numbers occurring in late April, which coincides with the spawning of the suckers. Twelve were seen on April 26, 1970, in the company of Ring-billed and California Gulls.

CALIFORNIA GULL. *Larus californicus.* Uncommon summer visitor, nesting at lakes adjacent to the area.

RING-BILLED GULL. *Larus delawarensis.* Common summer visitor, nesting at lakes adjacent to the area.

FRANKLIN'S GULL. *Larus pipixcan.* Uncommon to fairly common migrant and summer visitor.

BONAPARTE'S GULL. *Larus philadelphia.* Scarce to uncommon migrant, recorded at Little Fish Lake from April 26 to May 18, 1970, and on October 7, 1972.

*COMMON TERN. *Sterna hirundo.* Local summer resident. One pair was found nesting on an island in a small reservoir near Standard. At Little Fish Lake a small colony occupies several shallow islands, but nesting success appears to be low owing to the susceptibility of the islands to flooding.

*BLACK TERN. *Chlidonias niger.* Fairly common summer resident, nesting locally. Three nesting colonies are known for the area, two with less than 20 nesting pairs each and the other with over 100 nesting pairs.

*ROCK DOVE. *Columba livia.* Common resident, nesting on man-made structures and occasionally on cliffs.

*MOURNING DOVE. *Zenaidura macroura.* Common summer resident, nesting in a wide variety of habitats in the river valleys and coulees throughout the area.

BLACK-BILLED CUCKOO. *Coccyzus erythropthalmus.* Rare summer visitor, known from the observations of W. R. Salt at Rosebud during the breeding season. On June 24, 1934, a female with an enlarged ovum was collected. Two birds were seen July 4, 1935 (Salt, personal communication). There are no known recent sightings.

*GREAT HORNED OWL. *Bubo virginianus.* Fairly common resident, nesting in a wide variety of habitats. We have observed it nesting in old crow, hawk, and magpie nests and once in a Prairie Falcon eyrie.

SNOWY OWL. *Nyctea scandiaca.* Winter visitor, varying from fairly common in some years to scarce in others.

*BURROWING OWL. *Speotyto cunicularia.* Rare summer resident, known from few records. There is an old nesting record at Rosebud (Salt 1950) and a number of old sight records (Salt, personal communication). The most recent record is of one bird west of Hussar in April 1968.

*LONG-EARED OWL. *Asio otus.* Scarce summer resident, showing a distinct preference for dense brushy areas.

*SHORT-EARED OWL. *Asio flammeus.* Generally uncommon summer resident, fluctuating from scarce to fairly common, depending on the meadow vole (*Microtus pennsylvanicus*) population. A few have wintered in the area.

*SAW-WHET OWL. *Aegolius acadicus.* Known from four records, one on April 17, 1968, 4 miles north of Beynon when a nest containing six eggs was found. There are two winter records of birds found dead, one at Rosebud, December 20, 1942, and the other 4 miles south of Beynon on February 21, 1965. A bird was also found dead at Rosebud, June 8, 1933 (Salt, personal communication).

†COMMON NIGHTHAWK. *Chordeiles minor.* Scarce summer resident in the major stream valleys.

RUBY-THROATED HUMMINGBIRD. *Archilochus colubris.* Known from observations at Rosebud and Drumheller, usually around garden flowers (Salt, personal communication).

RUFOUS HUMMINGBIRD. *Selasphorus rufus.* An adult male was observed by W.R. Salt at Little Fish Lake on May 27, 1972. This is the easternmost record of this mountain species in Alberta.

†BELTED KINGFISHER. *Megaceryle alcyon.* Uncommon summer resident along streams.

*YELLOW-SHAFTED FLICKER. *Colaptes auratus.* Common summer resident, nesting in large poplars along streams.

*RED-SHAFTED FLICKER. *Colaptes cafer.* Rare summer resident, nesting in large poplars. Flicker hybrids with orange shafts are frequently observed.

†PILEATED WOODPECKER. *Dryocopus pileatus.* The first known occurrence of the Pileated Woodpecker in the area was a single bird seen from 1958 to 1959 at Beynon (Alberta Bird Reports 1958, 1959). On May 8, 1965, one was observed near Beynon in the vicinity of large holes in power poles. A female was observed, again near Beynon, on October 30, 1971. A male was sighted near East Coulee in an extensive poplar stand during late September of 1972. Nesting holes have also been found north of Beynon. This species has been noted recently along the Red Deer River upstream from Drumheller (Storer and Wilson 1972; Greenlee 1972; Kondla and Smith, unpublished manuscript).

RED-HEADED WOODPECKER. *Melanerpes erythrocephalus.* Known from an observation of an adult at Rosebud in June of 1932 or 1933 (Salt, personal communication). This is one of a number of summer observations in southern Alberta but, to date, there are no nesting records.

LEWIS' WOODPECKER. *Asyndesmus lewis.* One bird observed at Rosebud, April 29, 1929 (Salt, personal communication).

YELLOW-BELLIED SAPSUCKER. *Sphyrapicus varius.* Scarce fall migrant, reported during September.

HAIRY WOODPECKER. *Dendrocopos villosus.* Scarce winter resident.

DOWNY WOODPECKER. *Dendrocopos pubescens.* Scarce resident. Most observations are during the winter months.

BLACK-BACKED THREE-TOED WOODPECKER. *Picoides arcticus.* Two winter records of single birds at Beynon, one a specimen collected December 27, 1937, the other, a sight record January 24, 1965.

NORTHERN THREE-TOED WOODPECKER. *Picoides tridactylus.* Known from a specimen taken January 29, 1944, and sighting(s) near Drumheller (Salt, personal communication).

*EASTERN KINGBIRD. *Tyrannus tyrannus.* Common summer resident in shrubby areas and deciduous woods, often near water.

*WESTERN KINGBIRD. *Tyrannus verticalis.* Common summer resident in the poplar woods along the Red Deer River, rarely observed elsewhere.

EASTERN PHOEBE. *Sayornis phoebe.* Scarce migrant (Salt, personal communication).

*SAY'S PHOEBE. *Sayornis saya.* Fairly common summer resident of the bare and eroded slopes, occasionally nesting in old buildings.

TRAILL'S FLYCATCHER. *Empidonax traillii.* Migrant, abundance unknown. At least three were heard on August 13, 1972, at Rosebud. A specimen was collected May 25, 1936, near Rosebud (Salt, personal communication).

†LEAST FLYCATCHER. *Empidonax minimus.* Common summer resident of deciduous woods.

†WESTERN WOOD PEWEE. *Contopus sordidulus.* Fairly common summer resident of riverine poplar woods.

OLIVE-SIDED FLYCATCHER. *Nuttallornis borealis.* A single bird was observed on May 20, 1972, 8 miles north of Hussar.

*HORNED LARK. *Eremophila alpestris.* Fairly common summer resident, nesting on grazed and cultivated lands. Small numbers occasionally winter in the area.

TREE SWALLOW. *Iridoprocne bicolor.* Scarce summer resident around human habitations, possibly nesting in birdhouses.

*BANK SWALLOW. *Riparia riparia.* Fairly common summer resident, nesting in cutbanks along streams.

*ROUGH-WINGED SWALLOW. *Stelgidopteryx ruficollis.* Scarce to uncommon summer resident, nesting in cutbanks along streams.

*BARN SWALLOW. *Hirundo rustica.* Common summer resident, nesting on buildings. We have one record of a nest in a cave in the badlands.

*CLIFF SWALLOW. *Petrochelidon pyrrhonota.* Common summer resident, nesting most frequently on cliffs and bridges, occasionally on buildings.

PURPLE MARTIN. *Progne subis.* Known from two late May records, a male in 1971 near Drumheller and a female in 1972 near Beynon.

GRAY JAY. *Perisoreus canadensis.* An individual was seen at Beynon on December 24, 1958 (Alberta Bird Report 1958). This is considerably east and south of this species' range in Alberta.

*BLUE JAY. *Cyanocitta cristata.* Status in the area difficult to assess. It is conspicuous and regular outside the breeding season, but rarely seen during the nesting season. First observed in the study area in 1959 (Alberta Bird Report 1959). On May 9, 1970 a bird was seen carrying nesting material near Beynon. In 1971 an old nest was found in a spruce 5 miles south of Hesketh.

*BLACK-BILLED MAGPIE. *Pica pica.* Common resident throughout the area.

*COMMON CROW. *Corvus brachyrhynchos.* Common summer resident, nesting in isolated thickets and trees throughout the cultivated areas.

*BLACK-CAPPED CHICKADEE. *Parus atricapillus.* Fairly common resident throughout the wooded areas.

RED-BREASTED NUTHATCH. *Sitta canadensis.* Apparently a scarce summer resident in the more extensive spruce and mixed woodland. It is occasionally observed during winter, sometimes in fairly large numbers.

BROWN CREEPER. *Certhia familiaris.* Irregular fall and winter visitor in the extensively wooded areas of the coulees and river valleys.

*HOUSE WREN. *Troglodytes aedon.* Common summer resident in the deciduous woods and thickets.

†ROCK WREN. *Salpinctes obsoletus.* Common summer resident of bare slopes.

MOCKINGBIRD. *Mimus polyglottos.* Known from three records of single birds, all at Beynon — June 10, 1939; May 23, 1959; May 19, 1964 (Brazier 1964).

*CATBIRD. *Dumetella carolinensis.* Fairly common summer resident, most prevalent in the thickets along the river valleys and coulees.

*BROWN THRASHER. *Toxostoma rufum.* Fairly common summer resident in the same habitat as the previous species.

SAGE THRASHER. *Oreoscoptes montanus.* Known from one sight record near Drumheller on August 30, 1958 (Alberta Bird Report 1958).

*ROBIN. *Turdus migratorius.* Uncommon summer resident in natural habitat, but common around human habitations.

VARIED THRUSH. *Ixoreus naevius.* A specimen of a female seen foraging around a slough was collected on May 14, 1938 (Salt 1939).

HERMIT THRUSH. *Hylocichla guttata.* Uncommon migrant during May and September (Salt, personal communication).

SWAINSON'S THRUSH. *Hylocichla ustulata.* Scarce to uncommon migrant in May and September.

GRAY-CHEEKED THRUSH. *Hylocichla minima.* Spring migrant. Known from collections of single birds May 11, 1936 and May 25, 1937, at Rosebud and Drumheller (Salt, personal communication), and in the Hand Hills during the spring of 1970.

†VEERY. *Hylocichla fuscescens.* Known from several singing and calling birds at the summit of the Hand Hills during the midst of the breeding season. This

species has been found upstream (Dry Island Buffalo Jump Provincial Park) and downstream (Dinosaur Provincial Park) from the study area. Suitable nesting habitat occurs along the Red Deer River Valley and we suspect that it might be found there.

EASTERN BLUEBIRD. *Sialia sialis.* "Among a flock of migrating Mountain Bluebirds which visited the Beynon area on September 29th and remained for several days, was a male Eastern Bluebird. Miss M. Biggs observed this bird at close range on several occasions when the birds visited the vicinity of her home. She suspects that there were some female or immature Eastern Bluebirds in the flock also since some birds had reddish tinges on their underparts, but she vouches only for the male." (Alberta Bird Report 1959).

*MOUNTAIN BLUEBIRD. *Sialia currucoides.* Fairly common summer resident, nesting mainly in natural cavities on badland slopes.

TOWNSEND'S SOLITAIRE. *Myadestes townsendi.* Scarce spring migrant, recorded during March, April, and May. There are also records for the winter months at Beynon.

GOLDEN-CROWNED KINGLET. *Regulus satrapa.* Fairly common fall migrant and scarce spring migrant. We have no records between January and May despite fairly extensive field work in 1972.

RUBY-CROWNED KINGLET. *Regulus calendula.* Uncommon migrant, recorded during late April, May, and September (Salt, personal communication).

WATER PIPIT. *Anthus spinoletta.* Common migrant during April and September.

*SPRAGUE'S PIPIT. *Anthus spragueii.* Common summer resident in the fescue grassland of the Hand Hills, occasionally elsewhere in undisturbed grassland.

BOHEMIAN WAXWING. *Bombycilla garrulus.* Common winter visitor, most abundant around human habitations.

*CEDAR WAXWING. *Bombycilla cedrorum.* Fairly common summer resident, most frequently nesting in tall shrubbery, often adjacent water.

NORTHERN SHRIKE. *Lanius excubitor.* Uncommon migrant and scarce winter visitor.

*LOGGERHEAD SHRIKE. *Lanius ludovicianus.* Uncommon summer resident in tall roadside shrubbery. This species is most often observed in the eastern half of the study area.

*STARLING. *Sturnus vulgaris.* Common summer resident, most abundant along the Red Deer River Valley and around human habitations.

†RED-EYED VIREO. *Vireo olivaceus.* Scarce summer resident of aspen woods.

†WARBLING VIREO. *Vireo gilvus.* Uncommon summer resident, nesting in the large poplars of the river valleys.

BLACK-AND-WHITE WARBLER. *Mniotilta varia.* Rare spring and fall migrant (Salt, personal communication).

TENNESSEE WARBLER. *Vermivora peregrina.* Uncommon migrant (Salt 1938).

*ORANGE-CROWNED WARBLER. *Vermivora celata.* Common migrant and uncommon summer resident, utilizing the aspen woodland and the shrubbery of valley and coulee sides.

PARULA WARBLER. *Parula americana.* There is a report of one near Wayne and Rosedale in 1958 (Salt 1973).

*YELLOW WARBLER. *Dendroica petechia.* Common summer resident in deciduous shrubbery and woodlands, often in close proximity to water.

CAPE MAY WARBLER. *Dendroica tigrina.* Rare fall migrant (Salt 1938).

BLACK-THROATED BLUE WARBLER. *Dendroica caerulescens.* Known from one adule male which was collected near Rosebud on June 3, 1957 (Alberta Bird Report 1957).

MYRTLE WARBLER. *Dendroica coronata.* Common migrant during May and September.

AUDUBON'S WARBLER. *Dendroica auduboni.* Uncommon migrant (Salt 1938). Our observations, however, would indicate this species to be a rare migrant.

TOWNSEND'S WARBLER. *Dendroica townsendi.* Known from the record of an adult male collected at Rosebud on May 18, 1935 (Salt and Wilk 1966).

BAY-BREASTED WARBLER. *Dendroica castanea.* Known from a specimen taken September 6, 1934 (Salt, personal communication).

BLACKPOLL WARBLER. *Dendroica striata.* Uncommon migrant, observed at Rosebud, Little Fish Lake, and Drumheller (Salt, personal communication).

PALM WARBLER. *Dendroica palmarum.* Irregular fall migrant during September, and there are spring sight records (Salt 1938).

†OVENBIRD. *Seiurus aurocapillus.* Known from a record of a singing male in late June 1970 in the poplar woods near the summit of the Hand Hills. Previously in Alberta, this species was known to breed only in the deciduous and mixed woodlands north of Edmonton and in the foothills of the Rocky Mountains (Salt and Wilk 1966).

MOURNING WARBLER. *Oporornis philadelphia.* Known from the record of a singing male north of Beynon on May 28, 1972.

*MACGILLIVRAY'S WARBLER. *Oporornis tolmiei.* Uncommon summer resident in thick brush on hillsides and in coulees. This species has a discontinuous breeding distribution in Alberta, nesting in the western foothills region, the Cypress Hills, and the Drumheller area.

*YELLOWTHROAT. *Geothlypis trichas.* Common summer resident along streams, most noticeable in communities of sandbar willow (*Salix interior*).

†YELLOW-BREASTED CHAT. *Icteria virens.* Scarce summer resident. It was first observed in Alberta at Rosebud on June 6, 1941, when an adult female was collected (Salt and Wilk 1966). We feel that this species is more common than our records indicate.

WILSON'S WARBLER. *Wilsonia pusilla.* Regular migrant during May and September (Salt 1938).

CANADA WARBLER. *Wilsonia canadensis.* One bird seen at Rosebud, September 8 (Salt 1973).

AMERICAN REDSTART. *Setophaga ruticilla.* Rare spring migrant, but more abundant in the fall (Salt 1938).

*HOUSE SPARROW. *Passer domesticus.* Common resident, mostly in the vicinity of human habitations.

*WESTERN MEADOWLARK. *Sturnella neglecta.* Fairly common summer resident, nesting in the grasslands.

*YELLOW-HEADED BLACKBIRD. *Xanthocephalus xanthocephalus.* Summer resident, nesting locally in sloughs with extensive tall emergent vegetation — cattails (*Typha latifolia*) and bulrushes (*Scirpus* spp.).

*RED-WINGED BLACKBIRD. *Agelaius phoeniceus.* Common summer resident in a large variety of aquatic habitats.

*BALTIMORE ORIOLE. *Icterus galbula.* Common summer resident in the tall poplars along the Red Deer River Valley, less abundant in other deciduous woodlands.

RUSTY BLACKBIRD. *Euphagus carolinus.* Fall migrant, in small flocks.

*BREWER'S BLACKBIRD. *Euphagus cyanocephalus.* Fairly common summer resident, nesting most frequently in shrubby areas and in tall roadside grasses.

COMMON GRACKLE. *Quiscalus quiscula.* Known from two records, one on April 23, 1960, at Drumheller (Alberta Bird Report 1960) and the other on May 20, 1972, south of Beynon in a willow tangle adjacent to a large slough.

*BROWN-HEADED COWBIRD. *Molothrus ater.* Fairly common summer resident, foraging in grazed areas. In the area, this species has been found to parasitize Brewer's Blackbird, Red-winged Blackbird, Clay-colored Sparrow, Vesper Sparrow, Savannah Sparrow, and Western Meadowlark.

ROSE-BREASTED GROSBEAK. *Pheucticus ludovicianus.* A specimen was taken August 29, 1938, near Rosebud (Salt, personal communication).

*LAZULI BUNTING. *Passerina amoena.* "I have many sight records between Redlands and Beynon and took several specimens. There is no doubt they nested between Rosebud and Redlands in 1936 and 1937" (Salt, personal communication). In Alberta, this species nests regularly only in the foothills.

EVENING GROSBEAK. *Hesperiphona vespertina.* Scarce winter visitor, observed most often in residential areas.

PURPLE FINCH. *Carpodacus purpureus.* A female was taken May 11, 1935, near Rosebud (Salt, personal communication).

PINE GROSBEAK. *Pinicola enucleator.* Uncommon winter visitor, observed most often in residential areas, and dense spruce and mixed woodland.

HOARY REDPOLL. *Acanthis hornemanni.* Uncommon winter visitor, accompanying Common Redpolls. Of the redpolls banded by W. R. Salt at Rosebud around 1940, approximately 10% were of this species.

COMMON REDPOLL. *Acanthis flammea.* Common winter visitor in a wide variety of habitats.

PINE SISKIN. *Spinus pinus.* Fairly common migrant and uncommon summer resident, in a wide variety of habitats. Owing to the presence of considerable numbers during May, June, and July, there is a possibility that it nests in the area.

*AMERICAN GOLDFINCH. *Spinus tristis.* Common summer resident, nesting in shrubs.

RED CROSSBILL. *Loxia curvirostra.* Scarce winter visitor in the spruce woods, almost invariably accompanying White-winged Crossbills.

WHITE-WINGED CROSSBILL. *Loxia leucoptera.* Erratic winter visitor in spruce woods. It was common during the winter of 1971–1972 when there was an abundant cone crop, but in the winter of 1972–1973 it appeared to be almost absent in correlation with the poor cone crop.

*RUFOUS-SIDED TOWHEE. *Pipilo erythrophthalmus.* Common summer resident in thick tangles of rose, saskatoon, chokecherry, and willow.

LARK BUNTING. *Calamospiza melanocorys.* Scarce summer visitor in the grassland areas.

*SAVANNAH SPARROW. *Passerculus sandwichensis.* Common summer resident in grasslands, damp meadows, and dry slough bottoms.

*BAIRD'S SPARROW. *Ammodramus bairdii.* Common summer resident in the fescue grassland in the vicinity of Little Fish Lake.

LECONTE'S SPARROW. *Passerherbulus caudacutus.* Known from the Rosebud area during the nesting season (Salt, personal communication).

*VESPER SPARROW. *Pooecetes gramineus.* Common summer resident in grassland and cultivated fields.

†LARK SPARROW. *Chondestes grammacus.* Uncommon summer resident in the badlands.

*SLATE-COLORED JUNCO. *Junco hyemalis.* Common migrant, during April, late September, and early October. Scarce summer resident in spruce woods at Beynon and Horseshoe Canyon. This species was known to breed only in the coniferous forests and mixed woods of northern and western Alberta (Salt and Wilk 1966). Our data constitutes a considerable range extension.

*OREGON JUNCO. *Junco oreganus.* Scarce migrant. There is a nesting record at Horseshoe Canyon in 1969. This represents a nesting range extension in Alberta, as this species was known to breed only in the Rocky Mountain and Cypress Hills regions (Salt and Wilk 1966).

TREE SPARROW. *Spizella arborea.* Common migrant during late March, April, late September, and October.

*CHIPPING SPARROW. *Spizella passerina.* Uncommon summer resident in aspen and mixed woods.

*CLAY-COLORED SPARROW. *Spizella pallida.* Common summer resident in dense low shrubbery.

BREWER'S SPARROW. *Spizella breweri.* Known from one record of a singing male at Little Fish Lake during late May and early June of 1970.

HARRIS' SPARROW. *Zonotrichia querula.* Uncommon spring migrant during May. Fairly common fall migrant during late September and October.

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys.* Scarce migrant during May and September.

WHITE-THROATED SPARROW. *Zonotrichia albicollis.* Scarce spring migrant but fairly common in fall migration during September.

FOX SPARROW. *Passerella iliaca.* A specimen was collected by M. A. Biggs September 14, 1937, at Beynon.

LINCOLN'S SPARROW. *Melospiza lincolnii.* Scarce migrant. Specimens were taken near Rosebud, May 14, 1937 (Salt, personal communication).

†SONG SPARROW. *Melospiza melodia.* Common summer resident in the brushy areas along streams.

MCCOWN'S LONGSPUR. *Rhynchophanes mccownii.* Scarce migrant. Specimens have been taken at Rosebud (Salt, personal communication). This species is also known from the occasional summer visitors to the Little Fish Lake area during May and June of 1970.

LAPLAND LONGSPUR. *Calcarius lapponicus.* Common migrant during late March, April, late September, and October.

SMITH'S LONGSPUR. *Calcarius pictus.* A small flock observed at Little Fish Lake during May of 1970.

*CHESTNUT-COLLARED LONGSPUR. *Calcarius ornatus.* Common but local summer resident in grazed and mowed grassland areas.

SNOW BUNTING. *Plectrophenax nivalis.* Common winter visitor on roadsides and in fields.

Discussion

Avian representatives of eight of the 12 passerine "Bird Faunas" present in Canada, as outlined by Udvardy (1963), nest in the Drumheller area. These are the Slate-colored Junco, Black-capped Chickadee, and Orange-crowned Warbler of the Boreal Forest Fauna; the Least Flycatcher, Veery, Ovenbird, and Vesper Sparrow of the Eastern Ecotone Fauna; the Baltimore Oriole, Blue Jay, Brown Thrasher, Catbird, and Red-eyed Vireo of the Eastern Deciduous Forest Fauna; the Sprague's Pipit, Baird's Sparrow, and Chestnut-collared Longspur of the Prairie Fauna; the Western Wood Pewee, MacGillivray's Warbler, and Oregon Junco of the Western Coniferous Forest Fauna; the Western Kingbird, Western Meadowlark, Yellow-headed Blackbird, and Brewer's Blackbird of the Western Woodland Edge Fauna; the Say's Phoebe, Black-billed Magpie, and Mountain Bluebird of the Great Basin Fauna; and the Rock Wren of the Trans-Tehuantepec Montane Fauna. One cannot deduce from the above information that the study area has avian communities typical of the Boreal Forest, Aspen Parkland, Great Basin Desert, *et cetera.* It can, however, be concluded that the area does offer a wide variety of habitats (Figure 7) which are used by some of the species characteristic of those zones. This is confirmed by the fact that 92 species regularly nest in the area.

The physiography, directly (i.e. badlands) and indirectly (through the presence of spruce and aspen woodland), has played an important role in determining the avifauna. The study area encompasses the southeasternmost stands

of white spruce and the last extensive areas of aspen along the Red Deer River. It is significant that the aspen and spruce stands, which are frequently small in size and at the limits of their range, contain few of the bird species that are characteristic of the coniferous and deciduous forests to the north. The spruce woods are devoid of nesting arboreal, insectivorous and cone-feeding birds such as certain flycatchers, warblers, and finches. At the other extreme, the niches in the grasslands appear to be fully occupied.

For seven nesting species our records represent extensions beyond the breeding ranges defined by Salt and Wilk (1966). These are the Saw-whet Owl, Pileated Woodpecker, Blue Jay, Ovenbird, Slate-colored Junco, and Oregon Junco. The Blue Jay has only recently reappeared in other parts of southern Alberta, where it ranged three or four decades ago (Salt and Wilk 1966). Four species that formerly nested in the area but which are now absent are the Peregrine Falcon, Ruffed Grouse, Burrowing Owl, and Lazuli Bunting.

Extensive agricultural activities carried out in the grasslands are the prime agents of landscape change in the area. Few areas have been spared. As a result of the combination of historical and economic factors, the aspen woodland of the Wintering Hills and the aspen woodland and fescue grassland of the Hand Hills are relatively undisturbed. Because of their steep and narrow nature, most coulees have been avoided by man. As a result, the coulees are refuges for a wide variety of undisturbed habitats; consequently their ecological importance cannot be overemphasized.

The uniqueness of the Drumheller area lies in its avifaunal diversity. It is a meeting place for species representative of numerous biogeographical elements. Here, the songs and calls of the MacGillivray's Warbler, Slate-colored Junco, Blue Jay, and Say's Phoebe can create an extraordinary chorus.

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Literature Cited

Alberta Bird Reports for 1957, 1958, 1959, 1960. *Edited* by E. O. Höhn, W. R. Salt, and E. D. Beacham. Edmonton and Calgary Bird Clubs.

American Ornithologists' Union. 1957. Check-list of North American Birds. 5th edition. Ithaca, New York.

Brazier, F. H. 1964. Status of the Mockingbird in the Northern Great Plains. Blue Jay 22: 63–75.

Coupland, R. T. 1950. Ecology of mixed prairie in Canada. Ecological Monographs 20: 272–315.

Craig, B. G. 1957. Surficial geology — Drumheller, Alberta. Canadian Department of Mines and Technical Surveys, Geological Survey of Canada Map 13-1957, Sheet 82P.

Greenlee, G. M. 1972. Pileated Woodpecker. Blue Jay 30: 258.

Irish, E. J. W. 1967. Geology Drumheller, Alberta. Geological Survey of Canada, Department of Energy, Mines and Resources Map 5, 1957, Sheet 82P.

Irish, E. J. W. 1970. The Edmonton group of south-central Alberta. Bulletin of the Canadian Petroleum Geologists 18(2).

Owens, R. A. 1971. The effects of several agricultural regimes on populations of native passerine birds of an Alberta fescue grassland. M.Sc. Thesis. Department of Biology, University of Calgary, Calgary, Alberta.

Pinel, H. W. and **C. A. Wallis.** 1972a. Unusual nesting record of Red-tailed Hawk in southern Alberta. Blue Jay 30: 30–31.

Pinel, H. W. and **C. A. Wallis.** 1972b. A botanical investigation in the Drumheller area, Alberta. Blue Jay 30: 169–194.

Salt, W. R. 1938. Notes on the warblers of the Rosebud district, Alberta. Canadian Field-Naturalist 52: 134–135.

Salt, W. R. 1939. Unusual records of birds in Alberta. Canadian Field-Naturalist 53: 59–60.

Salt, W. R. 1950. The Burrowing Owl in Alberta. Canadian Field-Naturalist 64: 221.

Salt, W. R. 1958. Black-throated Blue Warbler in Alberta. Canadian Field-Naturalist 72: 165.

Salt, W. R. 1973. Alberta vireos and wood warblers. Provincial Museum and Archives of Alberta Publication Number 3.

Salt, W. R. and **A. L. Wilk.** 1966. The birds of Alberta. 2nd edition. Government of Alberta, Department of Industry and Development, Queen's Printer, Edmonton, Alberta.

Smith, W. W. and **C. R. Wershler.** 1971. Some 1970 southern Alberta bird observations. Blue Jay 29: 83–85.

Storer, J. E. and **M. Wilson.** 1972. Pileated Woodpecker near Drumheller, Alberta. Blue Jay 30: 97.

Taverner, P. A. 1919. The birds of the Red Deer River, Alberta. Auk 36: 1–21, 248–265.

Udvardy, M. D. F. 1963. Bird faunas of North America. Proceedings XIII International Ornithological Congress. pp. 1147–1167.

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Tenth Census of Seabirds in the Sanctuaries of the North Shore of the Gulf of St. Lawrence*

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Nettleship, D. N. and A. R. Lock. 1973. Tenth census of seabirds in the sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 87: 395-402.

Abstract. Results of a 1972 summer census of seabirds in the sanctuaries of the north shore of the Gulf of St. Lawrence indicate that a very considerable decline in bird numbers has taken place at most of the colonies since 1965. Most of the decrease centers on sharp drops in Razorbills and puffins. Reasons for these declines are obscure, although persecution by man seems a likely prime cause of the puffin decrease in Bradore Bay.

Introduction

The future of many seabird populations in Canadian coastal waters is precarious, especially since pollution from human populations is not likely to stabilize or decline in the near future, and extensive areas of the continental shelf and Arctic islands are beginning to be subjected to oil drilling. This threat is particularly evident to seabird populations on the north shore of the Gulf of St. Lawrence where major increases in oil-tanker traffic and associated activity (oil spillage, oil terminals, etc.) are imminent. Thus, it is essential that a monitoring system sufficiently sensitive to detect real population changes in bird numbers at breeding sites be developed to establish a baseline from which to measure changes in seabird populations in the future.

Since 1925 censuses of non-passerine birds in the sanctuaries on the north shore of the Gulf of St. Lawrence (Figure 1) have been made every five years by the Canadian Wildlife Service in an attempt to monitor and assess changes in summer breeding populations (Lewis 1925, 1931, 1937, 1942; Hewitt 1950; Tener 1951; Lemieux 1956; Moisan 1962; Moisan and Fyfe 1967). Transportation from Carrousel Island Bird Sanctuary in the Bay of Sept Iles east to Blanc Sablon near Bradore Bay, and return, has previously been by boat, usually on Royal Canadian Mounted Police patrol cruisers. However, the discontinuation of these summer patrols by the R.C.M.P. after the 1965 census, resulted in no census' being conducted in 1970 and in a re-evaluation of census procedures and travel logistics for future surveys.

Although attempts were made to standardize the census procedures used in previous north-shore censuses (Lewis 1931, 1945), it is clear by looking over the previous census data that some of the recorded differences in bird numbers were not real, but artifacts due to deficiencies inherent in the census procedures used, such as individual observer bias or changes in time availability and R.C.M.P. boat crews. To avoid similar difficulties in the collection and interpretation of data in the future, it seemed imperative to develop and/or revise census techniques which would be of sufficient precision to measure *real* changes in numbers within individual colonies and which would be sufficiently rigid to reduce observer error to a minimum. Consequently, the object of the tenth census was to (1) test the adequacy of various new census techniques; (2) establish permanent census plots in some of the sanctuaries, which could be used in the future to measure changes in numbers of certain species with precision; (3) compare bird numbers recorded in 1972 with census results from 1965

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where possible; and (4) report the condition of each sanctuary. The overall objective was to establish a baseline for comparison of population changes over long periods, the data essential for the assessment of the effects of human activities upon seabird populations and the marine ecosystem.

The time required to accomplish the first two objectives resulted in a census period which extended later in the season (8 June to 15 July 1972) than the ninth census (14–25 June 1965), although inclement weather and a relatively late summer season may have offset any anomalies arising from differences in time of census at sanctuaries visited late. The present paper is limited to "primary" seabird species (i.e. petrels, cormorants, gulls, terns, and alcids). Less-detailed information concerning the distribution of Red-throated Loons (*Gavia stellata*) and Common Eiders (*Somateria mollissima*) in some of the sanctuaries is given in Nettleship (1973).

Methods and Procedures

The survey team (A. R. Lock, S. Homer, R. Kardos) used census procedures similar to those described by Lewis (1931, 1945) and used by Moisan and Fyfe (1967) in 1965, supplemented by new techniques (Nettleship 1972a) in some instances (see below). Transportation within each sanctuary was provided by Canadian Wildlife Service wardens or by charter from local residents.

Each colony was described in detail giving as much information as possible. General and detailed sketch maps were prepared to show the location of each colony or area censused, precise colony limits, and census methods, to ensure that valid comparative counts can be made in the future. Photographs were taken of some colonies, especially of cliff-nesting species, to provide a good record of colony size and to assist in accurately drawing the limits of colonies. Full details of the census results are reported by Nettleship (1973) and are available from the Canadian Wildlife Service Eastern Region Library.

In general, estimates of population size of resident breeding species at each colony were determined using the following census procedures:

Cormorants — Full nest counts were made of both cormorant species, although Double-crested Cormorants at Carrousel Island were censused by aerial photography because thick undergrowth and the diffuse nature of this tree-top nesting colony made ground counts difficult. Previous censuses were counts of nests from the ground.

Gulls — Gull census figures were derived from one or more of the following methods: (1) full nest count (Herring Gull, Ring-billed Gull, kittiwake, (2) nest estimate using line-transect techniques to sample the total nesting space (Herring Gull), (3) breeding-pair estimate by a boat count of adults standing or flying over the colony, multiplied by the ratio of nests to adults recorded on control areas selected prior to the boat count (Herring Gull), or (4) boat count of adults alone (Great Black-backed Gull). A nest was considered to be any structure more elaborate than a sample scrape (i.e., it had to have some built-up edge to qualify). The single difference between these techniques and those used during earlier censuses is the use of correction factors (method 3) to estimate the total number of Herring Gull pairs.

Terns — Few tern nests were found and so the size of each population was estimated by counting the total number of adults present at the colony. No attempt was made to distinguish between Arctic and Common Terns at mixed-species colonies, although a ratio of Arctics to Commons was derived whenever possible. Previous estimates of terns were based on counts of birds and/or nests.

Alcids — Razorbill and murre counts were based on egg and/or nest-site counts alone or, where total egg counts were not possible (e.g., certain murre ledges), by determining the ratio of birds present on control ledges and the total number of eggs and/or young on the same ledges, and using this ratio to calculate the number of pairs for all inaccessible colonies. Black Guillemots were estimated from counts of birds seen during a circuit of the island by boat. Puffins were carefully censused using grid

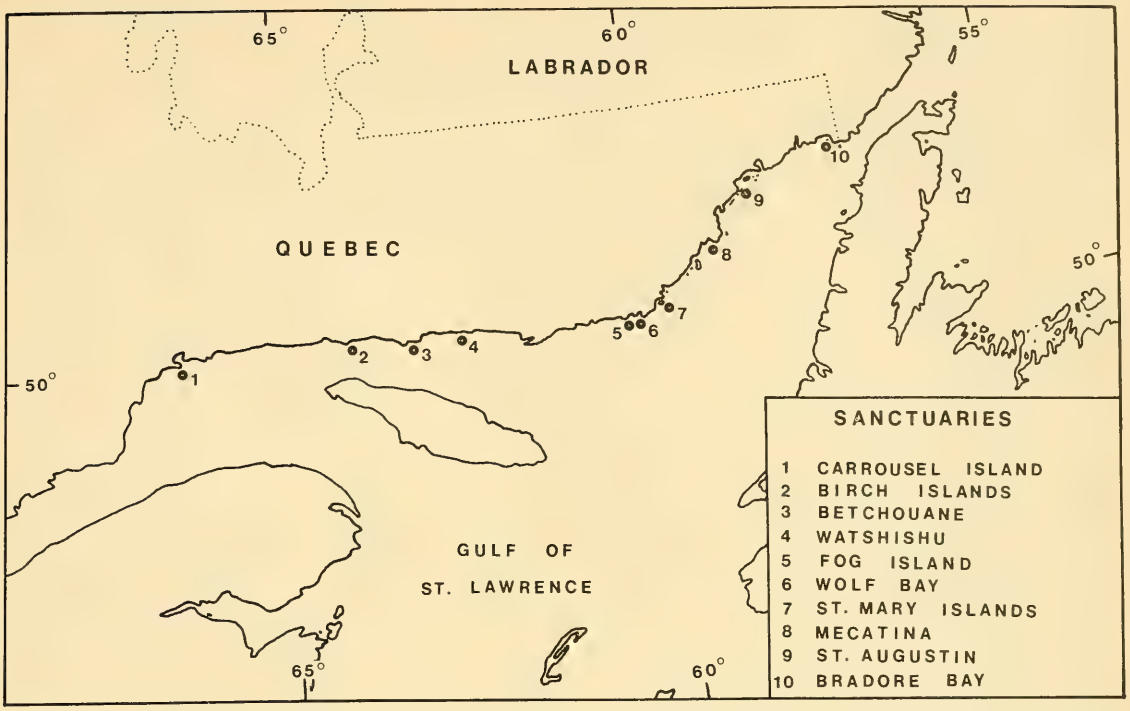

FIGURE 1. Sketch map showing approximate locations of the sanctuaries of the north shore of the Gulf of St. Lawrence.

and line-transect procedures (Nettleship 1972a, b; Grant and Nettleship 1971). These methods are comparable with those of other years, although the determination of burrow number and status (active or inactive) at puffin colonies was more detailed in 1972, as were estimates of murres on inaccessible ledges.

Although the 1972 survey appears to be comparable with censuses made previously because of similar census techniques, there are at least three differences which can be identified even if the methods used in the censuses are assumed to be identical (which, of course, they are not): first, and perhaps most important, is the fact that previous census teams had a relatively shorter time period available to census any single sanctuary (because of the R.C.M.P.'s boat schedule), which would of necessity result in less thorough counts being performed; second, the unknown effect on bird numbers of different weather conditions (local differences between years and either an early or late summer season) at time of census; and third, the time at which the censuses were made. The significance of these factors to observed differences in bird numbers is difficult to assess, but even with this limitation it does seem important to compare the 1972 population figures with those recorded in 1965 in an attempt to detect major differences which may seem unlikely to be due to any change in methodology alone.

Results and Discussion

The results given in Table 1 show that the total number of birds has apparently declined by about one-third since 1965. Of the 13 species censused, eight appear to have declined (Herring Gull, Common and Arctic Terns, Caspian Tern, Razorbill, Common Murre, Black Guillemot, Common Puffin), four increased (Great Cormorant, Double-crested Cormorant, Ring-billed Gull, Black-legged Kittiwake), and one remained about the same

TABLE 1. — Census of seabirds (number of individuals) in the bird sanctuaries of the north shore of the Gulf of St. Lawrence 1965[a] and 1972

Bird species	Caroussel Island		Birch Island		Betchouane		Watshishu		Fog Island		Wolf Bay		St. Mary Islands		Mecatina		St. Agustin		Bradore Bay		Totals	
	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972	1965	1972
Leach's Petrel *Oceanodroma leucorhoa*												+[b]										
Great Cormorant *Phalacrocorax carbo*												24	365	440							365	464
Double-crested Cormorant *Phalacrocorax auritus*	230	330	14			3	270	155				120	210	320				3			724	931
Great Black-backed Gull *Larus marinus*	60	55	95	75	50	70	102	295	215	135	270	240	575	450	110	85	115	155	2	2	1594	1562
Herring Gull *Larus argentatus*	7000	3600	3100	5525	1200	890	170	25	125	125	1100	730	1400	2205	460	40	3760	2000			18315	15140
Ring-billed Gull *Larus delawarensis*					150				150	3								445			300	448
Black-legged Kittiwake *Rissa tridactyla*	380	1830	275	930	25					1								5			680	2766
Common & Arctic Terns *Sterna hirundo* & *S. paradisaea*			160	25	3		1490	350	45	50	35		40	20	35	45		215			1808	705
Caspian Tern *Hydroprogne caspia*									10	2											10	2
Razorbill *Alca torda*	100	130			390	100	29	21	40	4	11000	2295	1675	1765	16			5	1700	+	14950	4320
Common Murre *Uria aalge*		4			25						1000	1510	6120	4120				1	5		7150	5635
Black Guillemot *Cepphus grylle*	165	20	3	8			23	6	200	55	18	61	375	330	73	15	50	31	1		908	526
Common Puffin *Fratercula arctica*					430	190			18		12500	9510	1325	600		2		9	21000	14540	35273	24851
Totals	7935	5969	3647	6563	2273	1253	2084	852	803	375	25923	14490	12085	10250	694	187	3925	2869	22708	14542	82077	57350

[a]Census figures from Moisan and Fyfe (1967).
[b]Indicates species present but insufficient time available to execute precise counts.

(Great Black-backed Gull). However, caution must be exercized in attempting to make comparisons with population estimates made in 1965 as some of the variation observed, as mentioned earlier, may be simply because the surveys were not made by the same people. Nevertheless, it does seem likely that the total north-shore seabird population is experiencing a real decline.

Insufficient time caused by poor weather prevented an accurate census of Razorbills in Bradore Bay Sanctuary. However, since all major changes at other colonies were decreases it is unlikely that the overall decline observed would be reversed by the inclusion of figures for this site.

Carrousel Island was censused on 8–9 June and found to be in good condition with no obvious molestation of breeding birds. The total number of birds appears to have declined since 1965, the decrease being due almost entirely to a 40–50% reduction of the Herring Gull population. Black Guillemot populations may also be decreasing, but variations in apparent numbers of this species are often associated with time of day and phase of the breeding cycle. Kittiwakes have increased in number dramatically and account for more than half the total number breeding along the north shore. Numbers of Double-crested Cormorants and Razorbills have also increased, but the change in numbers may reflect different census techniques (e.g., cormorant nests were counted from photographs taken from a low-flying aircraft instead of from the ground). Great Black-backed Gull numbers seem to be stable. The discovery of two pairs of Common Murres nesting on a ledge close to Razorbills represents an addition to the list of breeding birds.

In the *Birch Islands Sanctuary* near Mingan (census, 10–11 June) the only significant changes were increases in numbers of Herring Gulls and kittiwakes, and a decrease for terns. The sanctuary is in poor condition with empty shotgun shells, camp sites, and shot birds (mostly gulls) providing abundant evidence of molestation.

Betchouane Sanctuary (census, 13 June) appeared to have deteriorated, probably from human persecution (assumption based on number of empty shotgun shells found). With the exception of Great Black-backed Gulls, all species were less numerous than previously with the complete disappearance of Ring-billed Gulls, kittiwakes, terns, and murres. Three Double-crested Cormorants were seen but no nests were found.

The *Watshishu Sanctuary* population (census, 14–15 June) has declined to almost 40% of its previous size since 1965. Most of the decrease is due to the large decline of terns. Double-crested Cormorants and Herring Gulls also show major reductions in numbers. Only Great Black-backed Gulls have increased. Few gull nests contained eggs, which suggest large-scale egging.

Bird numbers in the *Fog Island Sanctuary* (census, 27 June) have also dropped significantly. Both the Ring-billed Gull and Caspian Tern colonies have disappeared, although individuals of both species were seen away from land. Great Black-backed Gulls were reduced in numbers as were Razorbills, Black Guillemots, and puffins. Numbers of Herring Gulls and Common and Arctic Terns have remained stable. Egging is a traditional activity on the islands and it seems likely that this may have caused the extirpation of Ring-billed Gulls and Caspian Terns (both nest in small dense colonies) within the sanctuary.

In *Wolf Bay Sanctuary* (census, 28–30 June), the tern colony had disappeared, and a sharp decrease (80%) in Razorbill numbers was detected. The difference between puffin numbers in 1965 and 1972 may be an artifact of different census methods, perhaps due to an inflated 1965 estimate, but the magnitude of the difference recorded for Razorbills suggests that part of the decrease is real. The gull population has remained relatively static. A colony of Double-crested Cormorants was found on an outer islet, as well as a small breeding group of Great Cormorants just outside the official sanctuary limits. Small numbers of Leach's Petrels were found nesting on Wolf Island, a previously unknown colony. Even though there is no resident warden at Wolf Bay, the sanctuary appears to be in fair shape.

Further reduction in bird numbers was noted in *St. Mary Islands Sanctuary,* the most serious of which is the apparent continued decline of murres and puffins. The number of Herring Gulls has almost doubled, although that of Great Black-backed Gulls have decreased slightly. The number of Razorbills and Black Guillemots seem to have remained about the same, but cormorants showed a significant increase. Very poor weather (rain and fog) resulted in an extended census period at the sanctuary (census, 18–26 June, 2–6 July).

Few outstanding changes have taken place in either the *Mecatina* (census, 6 July) or *St. Augustin* (census, 15 July) *Sanctuaries.* Most species were present in the same order of magnitude as encountered previously, although populations of Herring Gulls and Black Guillemots seem to have decreased appreciably. The most striking feature was the reappearance of Ring-billed Gulls in St. Augustin. Three colonies were found, but L. Martin (warden) says that Grassy Island (local name) is the original nesting site, the other two colonies being established only within the last two or three years. It is possible that the original colony was present in 1965 but went undetected. Egging and shooting are common events in both sanctuaries and may be responsible for the low number of resident birds.

In *Bradore Bay Sanctuary* puffins have decreased to a small fraction of their former numbers. A detailed survey was made of the distribution, numbers, and status of puffins in the Bay from 6–13 July. The results indicate a total population of 7,270 pairs, of which 4,625 nest on Perroquet Island; there are 2,645 pairs on Greenly Island. These figures fall well below those for 1965 and all previous estimates, although the absolute decrease cannot be determined because of different criteria used to determine status of burrows (active: *1965* — burrows lacking obvious signs of being unoccupied, such as untrampled green plants at burrow entrance and/or the presence of spider webs; *1972* — burrows with an egg, chick, egg shell fragments, chick down, nest material, defecation stains, etc.). However, it does seem likely that a large drop in numbers has occurred since 1925, especially on Perroquet Island. At present, active burrows on Perroquet are largely near rocky areas with few on open grassy regions; in 1925 the opposite was true (Lewis 1945). One likely explanation for this change is direct human persecution. The colony is known to have long been subjected to extensive egging and shooting by residents from Blanc Sablon, and all that can be said from the available evidence is that most of the grassy interior of the colony has been systematically dug up by eggers. One consequence of these activities is to restrict nesting to those areas where the eggs and incubating adults are inaccessible, among the rough sandstone rock boulders. Unlike Perroquet Island, there was little indication of any molestation of birds at Greenly Island, though puffins are known to nest only amongst rock fragments at this site. The only other seabird species seen in the sanctuary were Great Black-backed Gulls (one breeding pair on Perroquet Island) and Razorbills.

Conclusions

Comparison of 1972 census figures with counts made in the past is difficult. Clearly, neither the data from previous censuses nor our 1972 figures are sufficiently standardized to allow precise comparisons of population estimates (general biases between censuses include: differences in time, weather, accuracy, methodology), but they should be adequate to detect substantial numerical changes and geographic shifts. For this reason, the 1972 results are compared with those recorded in 1965 in the text that follows, even though the absolute number differences are liable to great error.

It seems reasonably clear from the census results that the seabird population on the north shore of the Gulf of St. Lawrence is diminishing both in numbers and species diversity. The apparent large decreases in terns, Razorbills, and puffins are probably real, as is the large increase in kittiwakes. It can be argued that the late breeding season in 1972 (due to inclement weather) may have been responsible for

the lower number of birds recorded. However, such an explanation seems unlikely since, it is known that although adverse climatic factors can reduce annual productivity (Langham 1972; Lemmetyinen 1972; Nettleship 1972b; Nisbet 1972; Palmer 1938), the average number of birds at the colony remains relatively constant even though egg-laying dates and frequency may change (Nettleship 1972b; Palmer 1941).

This suggests that the local populations of several species are truly threatened, although the precise rate of the declines remains unknown. The most striking result is the fact that, in general, all species that appear to have significantly decreased in numbers are highly specialized types (e.g., terns, alcids), whereas those that show a large increase or have remained about the same are not (e.g., gulls). This is consistent with seabird population trends reported elsewhere (Bourne 1972a, b; Brun 1971; Kadlec and Drury 1968; Harris 1970; Hickling 1969).

Reasons for these declines are obscure, although persecution by man emerges as a likely prime cause of the puffin decrease in Bradore Bay. The reduction in terns may also be related to human disturbance, similar to the factors responsible for the marked decrease in Common and Arctic Terns recorded along the New England coast (Nisbet 1973).

In addition to executing repeat censuses using the same techniques as in 1972 and reassessing present management practices (e.g., positioning of wardens in relation to important sanctuaries: Wolf Bay, St. Mary Islands, Bradore Bay) there is an urgent need to initiate detailed biological studies (breeding biology, feeding ecology, winter distribution, toxic chemical residues) and oceanographic studies (changes in water characteristics, productivity), if these changes are to be fully understood. The decline in Razorbills does not appear to be associated with molestation, and it is therefore important to find out whether other species too have been affected by less obvious and immediate causes such as toxic chemical residues, found in significant quantities in birds collected elsewhere in the Gulf of St. Lawrence (Pearce, et al. 1973).

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Literature Cited

Bourne, W. R. P. 1972a. The decline of auks in Great Britain. Biological Conservation 4: 144–146.

Bourne, W. R. P. 1972b. Threats to seabirds. International Council Bird Preservation Bulletin XI: 200–218.

Brun, E. 1971. Population changes of some seabirds in south Norway. Sterna (Stavanger Museum) 10: 35–56. (In Norwegian with English summary.)

Grant, P. R. and **D. N. Nettleship.** 1971. Nesting habitat selection by puffins *Fratercula arctica* L. in Iceland. Ornis Scandinavica 2: 81–87.

Harris, M. P. 1970. Rates and causes of increases of some British gull populations. Bird Study 17: 325–335.

Hewitt, O. H. 1950. Fifth census of non-passerine birds in the sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 64: 73–76.

Hickling, R. A. O. 1969. The increase of gulls. Ibis 111: 445.

Kadlec, J. A. and **W. H. Drury.** 1968. Structure of the New England Herring Gull population. Ecology 49: 644–676.

Langham, N. P. E. 1972. Chick survival in terns (*Sterna* spp.) with particular reference to the Common Tern. Journal of Animal Ecology 41: 385–395.

Lemieux, L. 1956. Seventh census of non-passerine birds in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 70: 183–185.

Lemmetyinen, R. 1972. Growth and mortality in the chicks of Arctic Terns in the Kongsfjord area, Spitsbergen in 1970. Ornis Fennica 49: 45–53.

Lewis, H. F. 1925. The new bird sanctuaries in the Gulf of St. Lawrence. Canadian Field-Naturalist 39: 177–179.

Lewis, H. F. 1931. Five years' progress in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 45: 73–78.

Lewis, H. F. 1937. A decade of progress in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 51: 51–55.

Lewis, H. F. 1942. Fourth census of the non-passerine birds in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist: 56: 5–8.

Lewis, H. F. 1945. Notes on taking quinquennial bird census of non-passerine birds in 10 bird sanctuaries along the north shore of the Gulf of St. Lawrence. Canadian Wildlife Service Report (CWS C 929), Ottawa. 13 pp.

Moisan, G. 1962. Eighth census of non-passerine birds in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 76: 78–82.

Moisan, G. and **R. W. Fyfe.** 1967. Ninth census of non-passerine birds in the sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 81: 67–70.

Nettleship, D. N. 1972a. Seabird census techniques. Studies on northern seabirds. Number 4. Canadian Wildlife Service Report. Ottawa. 20 pp.

Nettleship, D. N. 1972b. Breeding success of the Common Puffin (*Fratercula arctica* L.) on different habitats at Great Island, Newfoundland. Ecological Monographs 42: 239–268.

Nettleship, D. N. 1973. Census of seabirds in the sanctuaries of the north shore of the Gulf of St. Lawrence, Summer 1972. Studies on northern seabirds. Number 20. Canadian Wildlife Service Report. Ottawa. 160 pp.

Nisbet, I. C. T. 1972. Disaster year for terns. Man and Nature, December 1972: 16–21.

Nisbet, I. C. T. 1973. Terns in Massachusetts: present numbers and historical changes. Bird-Banding 44: 27–55.

Palmer, R. S. 1938. Tern mortality along the Maine coast. Bird-Banding 9: 117–123.

Palmer, R. S. 1941. A behavior study of the Common Tern. Proceedings of the Boston Society of Natural History 42: 1–119.

Pearce, P. A., I. Gruchy and **J. A. Keith.** 1973. Toxic chemicals in living things of the Gulf of St. Lawrence. Proceedings of the Canadian Society of Fisheries and Wildlife Biologists, Canadian Society of Zoologists Symposium: Renewable resource management of the Gulf of St. Lawrence, 5 January 1973, Halifax, Nova Scotia.

Tener, J. S. 1951. Sixth census of non-passerine birds in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. Canadian Field-Naturalist 65: 65–68.

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Some Aspects of the Breeding and Mortality of Common Loons in East-Central Alberta

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Vermeer, K. 1973. Some aspects of the breeding and mortality of Common Loons in east-central Alberta. Canadian Field-Naturalist 87: 403-408.

Abstract. Common Loons initiated egg-laying from the second last week of May until the third week in June. The clutch size of loons was significantly larger in Alberta than in Minnesota, but there was no significant difference in size of eggs in those two locations. Seventy percent of the loon eggs hatched and 0.4 loons were calculated to fledge per breeding pair. Eggshell thickness appeared to be unaffected by low DDE residue levels in eggs. Considerable mortality of adult loons resulted from commercial fishing activities.

Introduction

The nesting requirements of Common Loons *Gavia immer* in Alberta will be discussed elsewhere (Vermeer 1973). Inasmuch as little was known about the breeding and mortality of this species in Alberta, information on those subjects was sought by the author in that province in 1972. Information was obtained also on residues of DDE in Common Loon eggs to determine whether they had any effect on eggshell thickness.

Methods

Data on the breeding of Common Loons was obtained on 19 eutrophic lakes, utilized by sport fishermen, in the Lac La Biche – St. Paul region of Alberta (Figure 1). The study was conducted with a 12-foot-long aluminum boat, equipped with a 9½-H.P. outboard engine. Lakes on which no breeding pairs were observed were checked twice during May and June. Lakes with breeding pairs were checked four to five times during May, June, the first half of July, and the last week of August to obtain data on hatching and fledging success. Shorelines were cruised, with frequent 15-minute stops, for the purpose of detecting loons. The circumference of all islands smaller than 30 acres was checked for nests by walking along the shore. Where dense brush and logs made walking difficult, the shoreline was investigated by wading in water parallel to the shore. Points and peninsulas along the shore of the mainland and islands larger than 30 acres were examined on foot for nests when loons were sighted in the vicinity. The checks in May and June lasted from 2 to 8 hours depending on the number of islands present and the size of the lake investigated. When we were familiar with most of the nesting locations, subsequent checks took less time.

Fishermen and game wardens were asked to collect loons that were caught in fishnets, illegally shot, or had died from other causes.

Most loon nests were found during incubation but a few were discovered during the egg-laying period. Clutches were back-dated from the time of hatching to obtain the date of clutch initiation. The calculation used in back-dating was based on one known incubation period of 27 days for loons in the study area.

One egg was collected from each of 15 clutches for polychlorinated biphenol (PBC) and organochlorine residue analyses. The contents of eggs were stored in glass jars and preserved by freezing. In addition the shells of the eggs were dried at room temperature for 4½ months, after which time their thickness was measured in order to relate shell thickness to the DDE levels found in the eggs. Thickness in each case represented the shell itself plus the dried egg membranes.

FIGURE 1. Location of lakes surveyed for breeding pairs of Common Loons in Alberta.

The PCB and organochlorine residue content of the egg samples were determined by Dr. L. M. Reynolds from the Ontario Research Foundation by the method described in Vermeer and Reynolds (1970). All residues were recorded in parts per million (ppm) on a wet-weight basis.

Results and Discussion

Clutch Initiation, Clutch, and Egg Size

Loons arrived in the study area as soon as the ice melted from the lakes. Ice disappeared from the smaller and shallower lakes during the first days of May, and from the larger and deeper lakes about one week later. The loons

initiated egg-laying from the second last week of May until the third week in June (Figure 2). In 1972 the mean date, at a 95% confidence interval, of clutch initiation was May 29 ± 4 days.

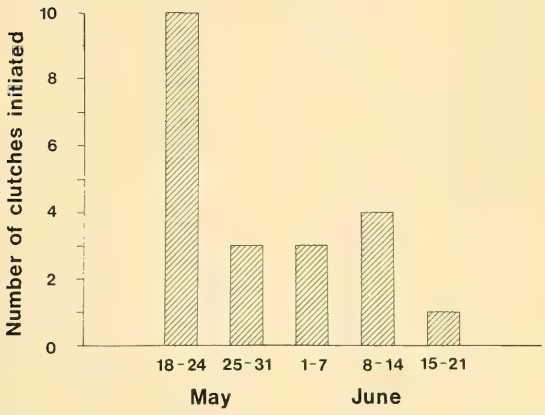

FIGURE 2. Clutch initiation for 21 clutches of Common Loons in Alberta in 1972.

Thirty-three breeding pairs of loons were observed on the 19 lakes surveyed. The nests of 26 pairs were found, and broods of two chicks each were observed for four other pairs whose nests were not located. Three pairs were thought to be breeders because of their occupation of the same localities and their vocalized reaction (yodeling and tremolo calls) each time the boat entered their territories. Of the 26 nests, two contained no eggs, five held one, 18 had two, and one had three eggs. One nest without eggs was abandoned when first observed. In the other nest without eggs, no eggs were laid, or eggs disappeared between visits. The mean clutch size (at a 95% confidence interval) for the 24 nests with eggs was 1.83 ± 0.20 eggs. Mean clutch size for 19 clutches with eggs reported from Alberta by Henderson (1924) was 2.05 ± 0.19 eggs. Comparisons between Common Loons in Alberta (Henderson 1924; this study) and Minnesota (Olson and Marshall 1952) show that the clutch size in Alberta was significantly larger than in Minnesota (Table 1). There were, however, no significant differences in the sizes of Common Loon eggs in those two locations (Table 2).

TABLE 1. — Comparison of clutch size of Common Loons in Alberta and Minnesota

Clutch size	Number of clutches		
	Alberta		Minnesota
	This study	Henderson 1929	Olson and Marshall 1952
1	5	1	21
2	18	16	26
3	1	2	
Mean ± 95% confidence interval	1.93±0.14		1.55±0.14

TABLE 2. — Comparison of egg measurements of Common Loons in Alberta (this study) and Minnesota (Olson and Marshall 1952)

Location	Number of eggs	Mean and 95% confidence intervals, in mm			
		Length	Range	Width	Range
Alberta	40	86.5±1.2	93.8–74.3	53.9±0.6	56.6–47.0
Minnesota	30	87.0±1.1	94.2–80.5	54.9±0.6	58.5–52.0

Reproductive Success

The hatching success of 37 loon eggs is shown in Table 3, where it may be seen that 70% of the eggs hatched. The hatching success was significantly higher ($P < 0.05$) for clutches with two eggs than for those with one egg (Table 4). The hatching rate of clutches from which eggs were taken (60%) did not differ significantly from those clutches which were left intact (74%). Avian predators were responsible for destroying at least four eggs.

TABLE 3. — Hatching success of 37 eggs of Common Loons in Alberta in 1972

Total number of eggs laid by 30 breeding pairs*	52
Number of eggs taken for pesticide analysis	15
Number of eggs preyed upon	4
Number of eggs disappeared (presumably eaten)	3
Number of eggs failed to hatch	3
Number of eggs deserted	1
Number of eggs hatched	26
Percentage eggs hatched	70%

*Included four broods with two loon chicks each (eight eggs).

The PCB and organochlorine residues in loon eggs were low (Table 5), as compared to those found in 1968 in other fish-eating birds in Alberta (Vermeer and Reynolds 1970). Eggshell thickness has been found to be inversely correlated with the amount of DDE in the egg contents of many species (Faber et al. 1972). However, no correlation ($r = 0.07$) was found between DDE levels and shell thickness in the Common Loon eggs (Table 6) in this study, perhaps because the DDE levels were too low and/or the sample size too small to show a correlation.

TABLE 5. — PCB and organochlorine residues in 15 Common Loon eggs from Alberta, 1972

PCB and organochlorine residues	Means and 95% confidence intervals, in ppm wet weight
PCB	1.2 ± 0.4
DDE	1.7 ± 0.6
DDD	<0.1
p,p -DDT	<0.1
Dieldrin	<0.1
Endrin	<0.1
Heptachlorepoxide	<0.1
Benzene hexachloride	<0.1

Nine young loons, at an average age of 2 months, were found to have survived to the last week of August 1972. Inasmuch as 26 of 37 eggs hatched (Table 3), the fledging rate of loons was only 35% per egg hatched or 24% per egg laid. On that basis the original 52 eggs

TABLE 4. — Comparison of hatching success for different clutch sizes of Common Loons

	Clutches with one egg		Clutches with two eggs		
	Found with one egg	Created by taking one egg from each nest	Found with two eggs	Created by taking one egg from one nest with three eggs	Broods with two chicks, presumably from clutches with two eggs
Number of clutches	5	13	5	1	4
Number of eggs	5	13	10	2	8
Total number of eggs hatched	2	7	7	2	8
Percentage eggs hatched	50		85		

TABLE 6. — Comparison of DDE residue levels with shell thickness and condition of embryos of 15 Common Loon eggs

DDE, in ppm wet weight	Eggshell thickness, in microns	Condition of embryo in analyzed egg
4.82	594	Embryo alive
1.28	529	Embryo alive
1.02	582	No embryo, fresh egg
0.84*	435	Embryo alive
1.38	561	Embryo alive
1.55	636	Embryo alive
0.89	617	Embryo alive
2.06	579	Embryo alive
1.19	607	Egg foul
2.31	544	Embryo alive
1.07	581	Embryo alive
1.09	635	Embryo alive
1.16	577	Embryo alive
3.03	549	Egg foul
1.31	565	Egg deserted
Mean ± 95% confidence interval		
1.7 ± 0.6	572.7 ± 27.4	

*Egg from three-egg clutch.

would probably have produced 13 fledglings, which is an average success of 0.4 fledglings per breeding pair. That success is similar to the fledging rate of 0.5 fledglings per breeding pair observed by Olson and Marshall (1952) in Minnesota.

Adult Mortality

Twelve adult loons were found entangled in fishnets and one adult was found shot in the Lac La Biche – Cold Lake – St. Paul region during 1972 (measurements of those loons are shown in the Appendix). Of the 12 enmeshed loons, 10 were caught in May and early June and two during August and September. Six other Common Loons, which were still alive when found in nets at Cold Lake, were released by fishermen (C. Scott, personal communication). Undoubtedly, an additional number of loons were caught in nets in east-central Alberta during 1972 and went unreported.

A total of 5,662 loons died in fishnets near Big Island at Great Slave Lake, N.W.T. during the last half of May and the first half of June in 1960 and 1961 (J. J. Keleher and C. G. Haight, July 18, 1973, personal communication). Of the 2,552 loons killed in 1961, 1,024 were unidentified, 1,489 were Red-throated Loons (*Gavia stellata*) and 39 Yellow-billed Loons (*Gavia adamsii*). Mortality of Common Loons and Yellow-billed Loons in fishnets have also been reported at Lake Winnipegosis, Manitoba by Bartonek (1965) and at Cambridge Bay, N.W.T., by Parmelee et al. (1967), respectively.

Acknowledgments

The author expresses his appreciation to Messrs. C. Scott and D. Unger of the Alberta Fish and Wildlife Division for assisting with the collecting of the loons caught in fishnets.

Literature Cited

Bartonek, J. C. 1965. Mortality of diving ducks on Lake Winnipegosis through commercial fishing. Canadian Field-Naturalist 79: 15–20.

Faber, R. A., R. W. Risebrough, and **H. M. Pratt.** 1972. Organochlorine and mercury in Common Egrets and Great Blue Herons. Environmental Pollution 3: 111–122.

Henderson, A. D. 1924. The Common Loon in Alberta. Condor 26: 143–145.

Olson, S. T. and **W. M. Marshall.** 1952 The Common Loon in Minnesota. Occasional Papers of the Minnesota Museum of Natural History 5: 1–77.

Parmelee, D. F., H. A. Stephens, and **R. H. Schmidt.** 1967. The birds of southeastern Victoria Island and adjacent small islands. Bulletin 222 of the National Museum of Canada, Ottawa. 229 pp.

Vermeer, K. 1973. Some aspects of the nesting requirements of Common Loons in Alberta. Wilson Bulletin. In press.

Vermeer, K. and **L. M. Reynolds.** 1970. Organochlorine residue in aquactic birds in the Canadian prairie provinces. Canadian Field-Naturalist 84: 117–130.

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APPENDIX — Measurement of 13 adult Common Loons from east-central Alberta, 1972

Sex	Length, in mm			Weight, in kilograms
	Culmen	Right wing (flat)	Total length	
Male	76.7	375	785	4.94
,,	81.0	385	830	4.85
,,	85.5	370	790	4.63
,,	—	364	764	3.67
,,	75.7	357	730	3.57
,,	56.2	324	685	2.72
,,	51.6	320	681	2.63
Female	78.6	360	755	3.76
,,	74.6	362	734	3.26
,,	71.5	350	725	3.26
,,	75.6	361	713	3.18
,,	75.8	365	745	3.18
,,	74.6	336	738	2.95
Mean ± 95% confidence interval	73.1±6.2*	356±12	744±25	3.58±0.47

*Significantly smaller than mean culmen length (81.8 ± 2.3) for 17 Common Loons measured in Minnesota by Olson and Marshall (1952).

Frogs of the Ontario Coast of Hudson Bay and James Bay

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Schueler, F. W. 1973. Frogs of the Ontario coast of Hudson Bay and James Bay. Canadian Field-Naturalist 87: 409-418.

Abstract. Six species of frogs occur along the northern coast of Ontario. Range extensions (*Hyla crucifer* to Attawapiskat, *Pseudacris* to Moosonee, *Bufo americanus* to Sutton Lake) and observations on the natural history of frogs in this area are presented. The study is based in part on field work in the springs of 1971 and 1972.

Introduction

This is a summary of the distribution and natural history of the frogs found in the grassland-tundra and adjacent boreal forest along the Ontario coast of James Bay and Hudson Bay. It is based on observations and collections made there during 1971 and 1972, collections Mr. Franklin D. Ross made during a visit to Moosonee in July 1968, and the collections of the Royal Ontario Museum (ROM) and National Museums of Canada, National Museum of Natural Sciences (NMC). All of my collections have been or will be deposited in the NMC.

Previous accounts of the herpetofauna of this area are those of Preble (1902), Logier and Toner (1961), and Cook (1968).

The Ontario coast of James and Hudson Bays is geologically homogeneous, a plain of Paleozoic sedimentary deposits emerging from the bays as it rebounds from the weight of the Wisconsin glaciation (Whitmore and Liberty 1968; Lee 1968), and it is largely covered by ponds, marshes, and bogs. Most permanent settlements are near the mouths of the large rivers that drain northern Ontario, and most collecting has been done near these settlements (Figure 1). We collected at five localities in or near towns along the coast. Frogs were the only amphibians or reptiles encountered. Ornithological observations will be reported elsewhere (Schueler, Baldwin, and Rising, in preparation).

Collecting Localities

Moosonee (14 June, 6–7 July 1971, 25–31 May, 4–6 June 1972). Moosonee is on the west bank of the Moose River, in spruce (*Picea mariana* and *P. glauca*) forest, largely surrounded by spruce–tamarack (*P. mariana* – *Larix laricina*) muskeg. We collected frogs mostly from disturbed habitats, notably ponds and ditches along roads in town (1971), and in the cleared area surrounding the airstrip north of town (1972).

Whitetop Creek Camp (11–14 June 1971, 31 May–4 June 1972). This camp is 20 km northeast of Moosonee, at the mouth of Whitetop Creek, near James Bay. Whitetop Creek is a small (*ca.* 1–2 m wide) stream, which has cut a steep-sided channel through open marshy meadow and willow (*Salix* spp.) thickets. Farther inland there are extensive stands of alder (*Alnus*) and willow about 5–10 m tall. In the open meadow there are many small shallow ponds, some of which were brackish in 1971.

Attawapiskat Camp (15–21 June 1971). Ten kilometers northeast of Attawapiskat on the north shore of the Attawapiskat River, this camp was in sedge meadow on the bank of the river, in an area dissected by many small streams and ponds. The vegetation around camp consisted of patches of willow brush and grassland; other habitats in the area included an extensive boggy marsh and dense

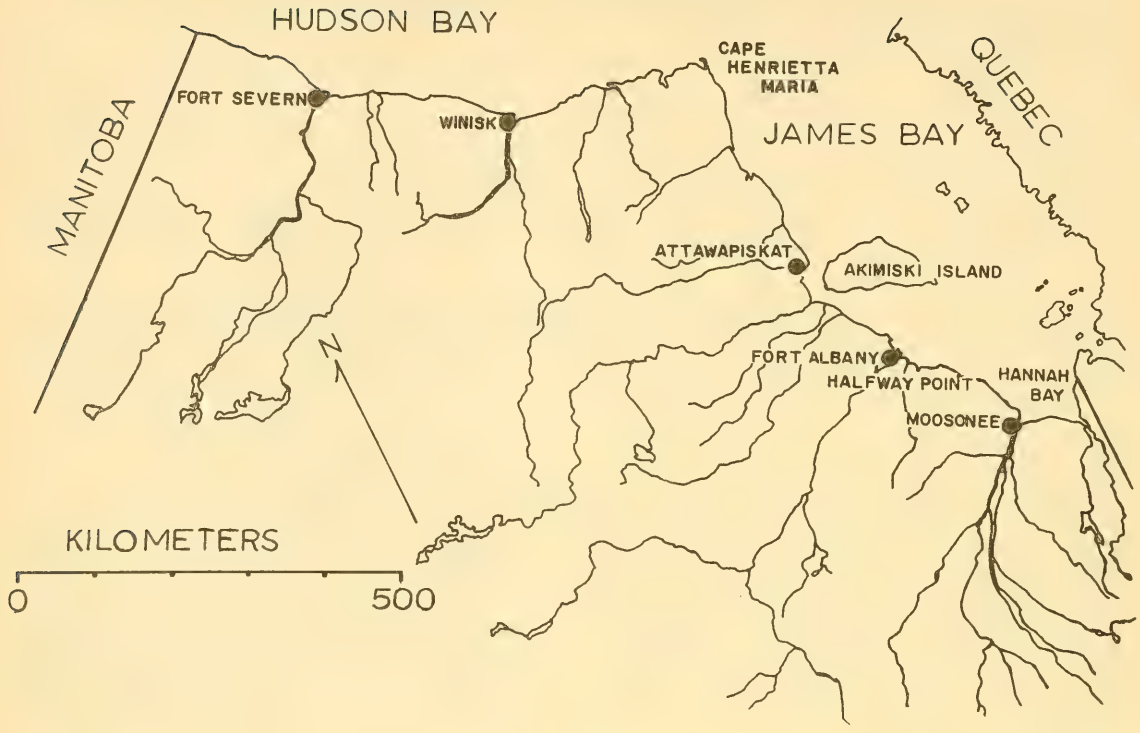

FIGURE 1. Map of northern Ontario showing some localities mentioned in the text.

alder–willow forest with larger, deeper (1.5 m) ponds.

Winisk Camp (22–28 June 1971). This camp is 4.8 km east of Winisk on the southeast shore of the Winisk River less than 1 mile from Hudson Bay. Peat tundra there, both dry and marshy, is dotted with many ponds, and is locally much disturbed by activities associated with the now-abandoned Winisk Royal Canadian Air Force Base.

Winisk (28 June–5 July 1971). The town is on the elevated west bank of the Winisk River, surrounded by dense willow–birch (*Betula* sp.) and spruce–tamarack thickets. There are several large ponds near the town.

Species Accounts

AMERICAN TOAD. *Bufo americanus*. Abundant at Moosonee, Whitetop Creek, and Attawapiskat. On 26 May 1972 we saw several aggregations of toads swimming in ditches along the Ontario Northland Railway right-of-way between Cheepas River and Moosonee. Toads were breeding at Moosonee on 14 June 1971 and 26–27 May 1972, and at Whitetop Creek on 12–14 June 1971 and 1–2 June 1972. On these nights amplexing pairs, newly-laid eggs, and tadpoles were abundant in shallow ponds in open areas. Few or no toads were calling on the cold nights of 28–31 May 1972. We took newly-hatched tadpoles in Moosonee on 5 June 1972 and saw no eggs or amplexing pairs that night, although many males were calling vigorously. Near the Whitetop Creek camp toads laid eggs in ponds that tasted brackish in 1971, but that were more or less fresh in 1972. Karlstrom (1966) noted that *Bufo boreas* in Valdez, Alaska bred in brackish beach ponds. It may be that the fresh water in some northern areas is so pure that lack of salts limits tadpole growth or development, and that the higher ion

TABLE 1. — *Bufo americanus* tadpoles from near James Bay

Date	Locality	Development*	Number of tadpoles	Museum
26 May 1972	Moosonee area	Oviposition	—	**
5 June 1972	Moosonee	19.5 (18–20)	45	NMC**
12–14 June 1971	Moosonee area	Oviposition	—	**
12–14 June 1971	Whitetop Creek	27.4 (27–28)	16	NMC**
21 June 1971	Attawapiskat	27.5 (25–28)	28	NMC**
7 July 1971	Moosonee	30.4 (27–37)	24	NMC**
9 July 1963	Moosonee	35.5 (35–36)	4	NMC
14 July 1920	Moose Factory	37.4 (36–39)	5	NMC
16 July 1934	E Shore Hannah Bay	36.1 (27–38)	15	ROM
17 July 1963	Fort George, Quebec	34.0 (29–36)	19	NMC (Cook 1964a)

*Mean stage of development and range, after Gosner (1960).
**My collections and observations.

content of ponds along the coast is better for tadpole development (see Greenwald 1972). At Attawapiskat males were calling from the edges of small ponds throughout the week that we were there, but no eggs or amplexing pairs were seen. Tadpoles averaging stage 27.5 (25–28) were taken, which suggests that at least one period of breeding had just ended when we arrived. Table 1 lists collections of toad tadpoles from the James Bay area, but since no collections are available from later in the summer than mid-July the length of the larval period remains uncertain. Tadpole development stages follow Gosner (1960); for each collection the mean is given, followed by the range.

Toads occur as Sutton Lake 100 km southeast of Winisk (Donald A. Baldwin, personal communication. ROM 10038). We did not see or hear any toads at Winisk, but they were said to occur there by local boys, some of whom were also acquainted with the species at Fort Albany.

All of the populations of toads that we saw resembled the nominal concept of *Bufo americanus copei* in their boldly mottled, brilliant brick-red, yellow, black, and white coloration, light mid-dorsal stripe, and stocky appearance. The geographic distribution, adaptive significance, and concordance of those characters which, when present in one population, characterize *B.a. copei,* present an interesting and as yet unanalyzed problem for students of species-level *Bufo* systematics (see Logier and Toner 1961, pp. 30–31; Ashton et al. 1973).

SPRING PEEPER. *Hyla crucifer.* A moderate chorus of this species was heard at Moosonee on the evening of 14 June 1971 and one calling male (NMC 15189) was taken from cattails (*Typha latifolia*) bordering a sandy pond there. No *H. crucifer* were heard in Moosonee on the evenings of 6 or 7 July 1971, nor at Whitetop Creek in 1971. In 1972 they were abundant and calling vigorously in Moosonee, particularly in the ditches along the railroad tracks through the muskeg south of town. A few were heard calling about 1 km inland from the Whitetop Creek camp, and two more specimens were taken (NMC 14795, 15265).

On 19 June 1971 we heard a single *H. crucifer* calling near the Attawapiskat camp, and on the night of 21 June I recorded and collected a male (NMC 15206) there. It was sitting on a Marsh Marigold (*Caltha palustris*) leaf about 1 m from a pond. The calls heard on 19 June included both single notes and trills.

Logier and Toner's (1961) northernmost Ontario record for this species was Lake Abitibi, Cochrane District, but McCoy and Durden (1965) found it at River Again, near

the south end of James Bay in Quebec, and Moore (1965) found it calling commonly in Moosonee on 5 July 1965.

BOREAL CHORUS FROG. *Pseudacris triseriata.* Common at all localities. Most of the individuals taken and heard calling were in the grassy borders of small ponds, and tadpoles were taken from such ponds at all localities.

We saw both eggs and tadpoles in ponds at Moosonee on 27 May 1972. On 1 June 1972 egg masses, both newly-laid and hatching, were abundant on grass and twigs at the edges of ponds at Whitetop Creek. Some eggs were laid just at water level on a floating mat of algae. On the nights of 1 and 2 June, great numbers of males called from the surface of the water, the edges of ponds, and floating vegetation. Females were present at the ponds but no amplexus was seen (perhaps all the ripe females had oviposited during several very hot days at the end of May). On 5 June 1972, there were more eggs (mostly around stage 9) in the pond where we had found eggs on 27 May, as well as large (stage 24.9, range 22–25) tadpoles. Another pond in Moosonee, in which there were no eggs, contained tadpoles which were at the same stage of development (24.8, range 21–26).

Tadpoles were often in small ponds and puddles; some were in ponds less than 1 m in diameter. The average development of the tadpoles in each of the 1971 collections fell in stages 25–27: Whitetop Creek (26.6, range 25–28); Attawpiskat (25.7, range 24–28); Winisk (27.0, range 24–28); Moosonee on 7 July (25.5, range 25–28. Small tadpoles were taken in preference to larger ones in this sample). The sample of 34 tadpoles from Attawapiskat included an albino individual in stage 26.

We found no *Pseudacris* eggs in 1971, heard only weak choruses in Winisk (although many frogs were taken), heard very few calls in Moosonee on 7 July 1971, and F. D. Ross heard only one call of this species in the Moosonee area on 22–23 July 1968, while Moore (1965) heard them 'in fine chorus' on 5–7 July 1965 in Moosonee, and Mr. George D. Bryant (personal communication) heard 'many chorus frogs' on Shipsands Island near Whitetop Creek, on the morning of 1 July 1972. Thus the few observations available suggest that, while breeding may be restricted to the spring, calling may continue sporadically through the summer, and the possibility of breeding after summer rains cannot be excluded.

In Moosonee, on the night of 27 May 1972, when *Pseudacris* and *Hyla crucifer* were calling vigorously, we did not hear *Pseudacris* south of Store Creek. *Pseudacris* seemed to be common in grassy areas around Moosonee, but scarce or absent in spruce forest or muskeg.

Logier and Toner (1961) report this species from Fort Albany and Fort Severn, Cook (1964b) mentioned the ROM specimens from Halfway Point, Moore (1965) heard it in Moosonee, and Dr. G. K. Peck (personal communication) recorded its calls at Cape Henrietta Maria in June 1970. It thus seems to occur all along the coast from Churchill, Manitoba, to the Moose River.

We took three back-color morphs of *Pseudacris:* green, grey-brown, and rusty-pink (Table 2), although some individuals were more or less intermediate (grey-green or tan). Matthews and Pettus (1966) and Matthews (1971) concluded that three Mendelian loci are likely responsible for color polymorphism in montane Colorado populations of this species, and it is possible that the same system is present in

TABLE 2. — Back color morphs of *Pseudacris* taken in northern Ontario, 1971–1972

Morph	Number of frogs taken			
	Whitetop Creek		Attawa-piskat	Winisk
	1971	1972		
Green	13	68	13	29
Brown or grey-brown	8	55	1*	0
Rusty-brown	2	1	0	0

*This frog was collected but not preserved.

northern Ontario populations. If this is the case, and if our 'rusty-pink' is the same as their 'red,' the 'red' is dominant and the green recessive to the 'grey-brown,' which is the only form found over much of the range of the species (e.g. southern Ontario (Cook 1964b) and eastern Colorado (Matthews and Pettus 1966)).

Bleakney (1959) presented evidence that the range of *Pseudacris* in southern Quebec and Ontario is limited by the Ottawa and St. Lawrence Rivers, which these frogs seem unable to cross. Since *Pseudacris* has never been taken east of the Moose River or any of its major tributaries (Logier and Toner 1961; Cook 1964b; McCoy and Durden 1965) it may be prevented from occupying the James Bay lowlands east of Moosonee by the rivers of the Moose River drainage.

MINK FROG. *Rana septentrionalis.* One specimen (NMC 14884) was taken in Whitetop Creek. In the area where it was taken the creek is about 1.5 m wide and 0.5 m deep, and runs through a forest of willows and alders. Logier and Toner (1961) report this species from Moose Factory, and F. D. Ross took one in Moosonee on 22 July 1968 (FDR 1746). It is surprising that this species has not been found farther north in Ontario, especially since Bleakney (1958) found it in northern Newfoundland Labrador.

WOOD FROG. *Rana sylvatica.* Common at all localities, except at the Winisk Camp where only one was collected, and at Attawapiskat, where it was extremely abundant.

Male *R. sylvatica* were calling from many small ponds and hatching eggs were taken in Moosonee on the night of 26 May 1972 and at Whitetop Creek on 1 and 2 June 1972. In 1972 no particularly loud choruses were heard, no amplexing pairs or newly-laid eggs were seen, and most of the females taken had recently ovivposited, while a few contained ovulated eggs. We did not hear any of the breeding calls of this species in 1971. Those seen in Moosonee on 14 June and 7 July 1971 were along roadside ditches and in meadows and brushy areas. At Winisk *R. sylvatica* was found in patches of grass and sedge, both along the Winisk River and among willow thickets, but the species was not nearly as conspicuous as it was at Attawapiskat. Where this species was common, small individuals (*ca.* 20 mm) tended to aggregate along the banks of streams and certain ponds, whereas the adults seemed more common in wooded areas and in open glades in the woods where they often avoided capture by jumping into small mammal burrows or among the roots of trees or bushes; but frogs of all sizes were found in all habitats. At Attawapiskat we frequently heard soft one- to three-syllable calls given by undisturbed frogs. These calls were similar to the 'chuckle' calls given by captive *R. sylvatica* (Wright and Wright 1949, p. 542) or *R. pipiens* (Schmidt 1968).

Dr. G. K. Peck (personal communication) recorded the calls of *R. sylvatica* at Cape Henrietta Maria in June 1970.

Eggs, possibly of *R. sylcatica,* were seen in ditches along the Ontario Northland Railway from Cochrane to Moosonee on 26 May 1972. Males were calling and tadpoles hatching in Moosonee that day, and at Whitetop Creek on 1–2 June 1972. Only two tadpoles were taken on 8 July 1971 in Moosonee; they were in stages 35 and 36. A collection of tadpoles (NMC 879) taken on 8 July 1920 at Fort Albany was at about the same stage of development, averaging 37.2, range 36–39) and F. D. Ross took a transforming tadpole (four legs and a tail) and a stub-tailed froglet in Moosonee on 22 July 1968. These data suggest that *R. sylvatica* breeds in mid-May in this region, and that the tadpoles have transformed by the end of July. Such a schedule would be similar to that of central Alaska *R. sylvatica* which breeds in mid-May and has a larval period of 53–64 days (Herreid and Kinney 1967). Figure 2 shows the relationship between snout–urostyle length of females from Attawapiskat and Winisk and the mass of their ovaries after preservation in formalin. The linear relationships between ovary mass and the size of the frogs indicate that all of these frogs probably bred that spring, since if some had not, more than one size class of ovary would be present at each locality. The ovaries of the Winisk frogs (mostly taken 1–5

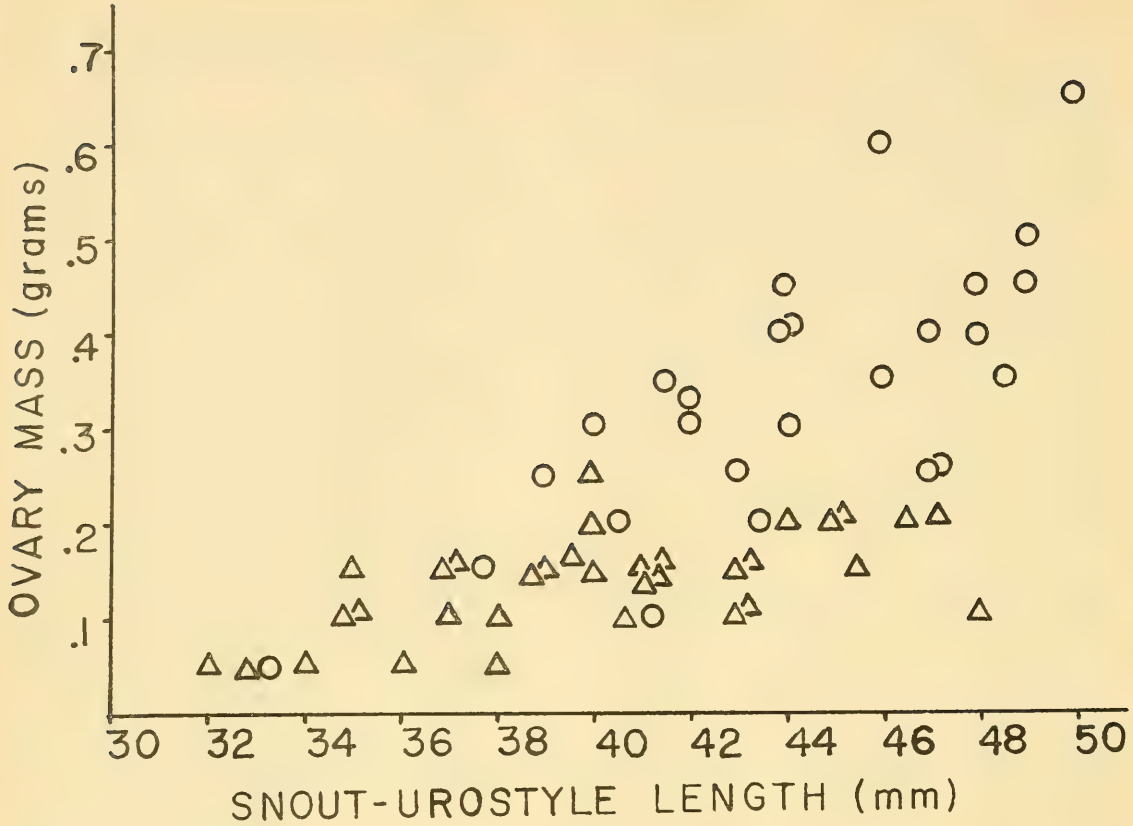

FIGURE 2. Relationship of ovary masses to snout-urostyle lengths of female *Rana sylvatica* from Attawapiskat and Winisk. Ovary masses taken after preservation in formalin. Attawapiskat frogs are indicated by triangles and Winisk frogs by circles. Note that the ovaries of the Winisk frogs (mostly taken 1–5 July) are larger than those from Attawapiskat (15–21 June).

July) are considerably larger than those of the frogs from Attawapiskat (15–21 June) suggesting that the ova enlarge quite rapidly at this season.

Figure 3 shows the distribution of sizes in the sample of frogs from Attawapiskat, as measured by snout–urostyle length. The only evident subadult age class is that centering on the 25.5–27.5-mm size class; these are presumably the 1-year-old frogs. Johansen (1962) noted great variability in the size of Alaskan *R. sylvatica* at metamorphosis; a similar situation seems to exist in northern Ontario. In Figure 3, for example, if the peak at 25.5–27.5 mm represents the 1-year-old frogs, this age class must have a range of at least 16–27 mm.

I made a preliminary analysis (Schueler, unpublished) of some pigmentation characters on the skins taken in 1971 (see Turner 1959, for a discussion of frog skinning; I dried the skins in a plant press between waxed papers rather than on glass). The characters were scored as qualitative multistate characters by comparison with standard specimens, and comparisons between samples were made with X^2 contingency tables of locality and character states ($P < 0.05$ for all of the differences referred to below). There is sexual dimorphism in the extent of red pigment on the backs and legs (females are redder than males), but no interlocality variation; the extent of ventral yellow varies between localities (Whitetop Creek frogs have

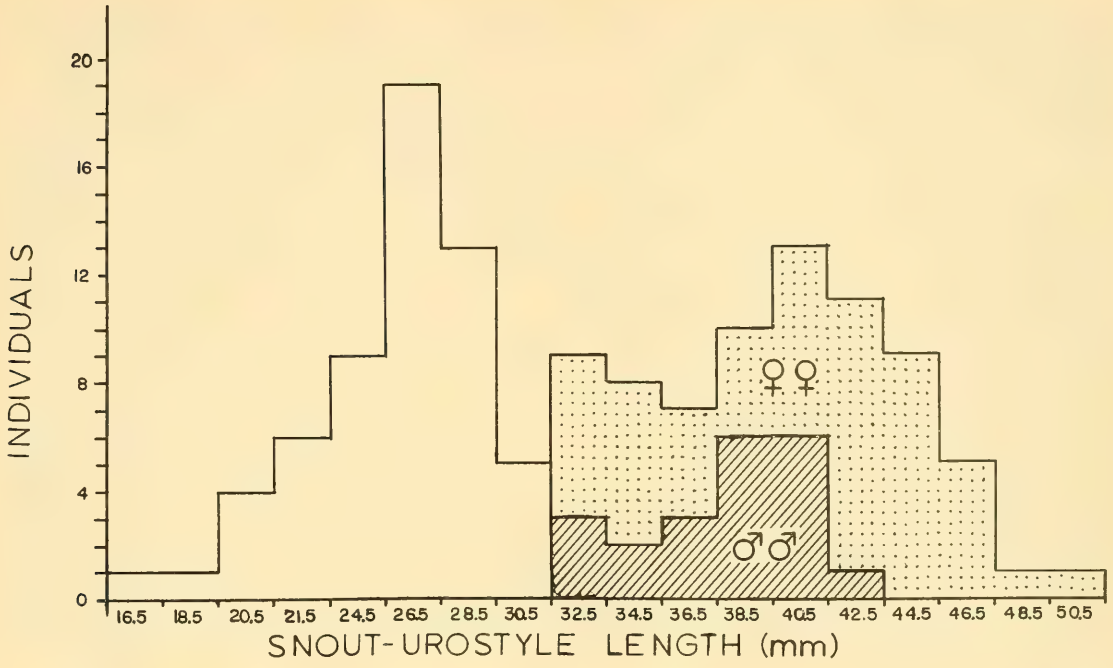

FIGURE 3. Histogram of sizes of *Rana sylvatica* taken at Attawapiskat, 15–21 June 1971. Females are shown by stippling, males by hatching, and unsexed juveniles by the unmarked area.

more yellow than those from Attawapiskat and Winisk), but there is no sexual dimorphism.

Black spotting and mid-dorsal stripes were similarly evaluated on these samples and on ROM alcohol specimens from Moosonee, Halfway Point, Fort Albany, Cape Henrietta Maria, and Fort Severn. Two characters, the amount of spotting between, and lateral to, the dorsolateral folds, showed variation along the coast: frogs from north of Attawapiskat were more heavily spotted than those from south of there. The amount of pigmentation along the dorsolateral folds, however, did not show any consistent north–south variation ($0.1 < P < 0.5$ for several combinations of localities). The mid-dorsal stripe characteristic of northern and western *R. sylvatica* (Browder et al. 1966; Martof 1970) showed a similar pattern of variation: of the frogs from south of Attawapiskat 57% were striped, whereas 77% of those from Attawipiskat and north were striped. This high incidence of striping is apparently found only in these coastal populations, as ROM collections of frogs from the interior of northern Ontario show a much lower incidence of it (Schueler and Cook, in preparation).

The overall pattern of variation among these samples, and in unquantified comparison with more southern populations, can be summarized as an increase in dorsal patterning in northern localities (see Martof and Humphries 1959; Martof 1970). This is not surprising, since the more northernly frogs are found in grassland to a greater extent than the southern ones, and in grassland dorsal spotting (*cf. Rana pipiens* and *R. palustris* and see discussion in Cott 1940 Chapter 4) and a dorsal stripe (cf. North American *Bufo* and European *Rana* and see Turner 1961 and Fishbeck and Underhill 1971) are more cryptic than the solid "dead-leaf" coloration of forest-dwelling southern *R. sylvatica.*

NORTHERN LEOPARD FROG. *Rana pipiens.* Uncommon at Moosonee, Whitetop Creek, and Attawapiskat. At Whitetop Creek a few *R. pipiens* were heard calling after dusk on 11 and

13 June 1971, and one adult female with spent ovaries was taken from a pond in open meadow. A few males were calling from ponds in this area in 1972, and one was taken. In Moosonee one frog was heard on the night of 14 June 1971, and seven calling males were taken from roadside ditches on the night of 5 June 1972. These individuals were dispersed along the deeper ditches, and we heard or saw frogs at some of these sites on the night of 27 May 1972. Two males and four females were taken from the banks of these ditches on 7 July 1971. One male, taken on the morning of 16 June 1971 while it was calling from a deep pond in an alder thicket near the Attawapiskat River, was the only adult encountered during the week at Attawapiskat. Four juveniles were taken from ponds and streams in sedge meadows along the hightide mark of this river.

Hatching egg masses were seen in ditches in Moosonee on 27 May 1972, and 12 tadpoles (stage 34.1, range 31–38) were taken from a pond near the Ontario Northland Railway station on 7 July 1971.

The desultory calling heard at Whitetop Creek, Moosonee, and Attawapiskat in 1971, the spent ovaries of the female taken at Whitetop Creek, and the eggs found in Moosonee suggest that *R. pipiens* breeds about the end of May in the James Bay region.

Logier and Toner (1961) report this species from Moosonee, Moose Factory, and Fort Albany, and Cook (1968) reported a specimen from 10 miles south of Winisk.

These northern *R. Pipiens* seemed more aquatic than those in southern Onatrio, and were never far from fairly deep water, in which they hid if pursued. All of the individuals seen were green, tending toward an olive green in the Attawapiskat and Whitetop Creek frogs, and toward a milky green in the Moosonee frogs, suggesting that the brown morph which

TABLE 3. — Distribution of frogs along the north coast of Ontario. NMC = National Museum of Canada; ROM = Royal Ontario Museum; * = my collections or observations; FDR = personal collection (now on long-term loan to NMC) of Franklin D. Ross; FRG = sight record by Dr. F. R. Gehlbach, reported in Logier and Toner (1961); GKP = recording by Dr. G. K. Peck, personal communication; ? = see text; (S) = sample used in analysis of geographic variation (see text).

Locality[1]	*Hyla crucifer*	*Pseudacris triseriata*	*Bufo americanus*	*Rana septentrionalis*	*Rana sylvatica*	*Rana pipiens*
East shore of Hannah Bay			ROM, NMC			
Harricanaw River			ROM		ROM	
Nattabisha Point			ROM		ROM	
Moose Factory			NMC	ROM	NMC	
Moosonee	NMC*	NMC*	NMC,* ROM	FDR	NMC,* ROM(S)	NMC*
Whitetop Creek	heard*	NMC*	NMC*	NMC*	NMC*(S)	NMC*
Halfway Point		ROM	ROM		ROM	
Fort Albany		ROM	ROM		ROM(S)	ROM
Attawapiskat	NMC*	NMC*	NMC*		NMC*(S)	NMC*
Akimiski Island		FRG	FRG		FRG	
Cape Henrietta Maria		GKP			ROM(S)	
Winisk		NMC,* ROM	?*		NMC*(S)	NMC
Fort Severn		ROM			ROM(S)	

[1]In southeast–northwest order along the coast. Akimiski Island is in the Northwest Territories, all other localities are in Ontario. Those from Fort Albany and south are in Cochrane District, those from Attawapiskat and north are in the Patricia portion of Kenora District.

is found at least as far north as Timmins, Cochrane District (personal observation) may not be present in these populations.

The specimen from Winisk (NMC 8993) is strikingly similar in color pattern to the specimens from Attawapiskat, and to a series in the ROM collection of *R. pipiens* from Lake Attawapiskat, Kenora District: all have many small roundish spots on the back and sides.

Discussion

Too many uncertainties remain in the ranges of frogs of northern Ontario (Table 3) to allow any zoogeographic analysis of the area, but some tentative conclusions about ranges are possible at the present time.

(1) *Rana pipiens* and *R. sylvatica* occur throughout Ontario.

(2) *Pseudacris triseriata* apparently is found continuously along the coast at least south to Store Creek in Moosonee; it is probably absent east of the Moose River, and its status in the interior is unknown (see Cook 1964b).

(3) The northern distributional limits of *Hyla crucifer* and *R. septentrionalis* remain uncertain since *H. crucifer* is conspicuous only in the early spring and *R. septentrionalis* is highly aquatic and is easily overlooked.

(4) *Bufo americanus* may occur north to Winisk.

(5) *Rana clamitans* almost certainly does not occur in the Moosonee area.

(6) We did not find *R. palustris*. A previous record from James Bay which has been variously treated (Preble 1902; Cook 1968; Logier and Toner 1961; Bleakney 1958) is based on misidentified *R. pipiens* (Cook and Schueler, in preparation).

(7) There seems to be a tendency among the frogs of this area, both in comparison with more southerly populations and between northern and southern populations within the region, toward patterns cryptic in grassy areas: dorsal spotting in *R. sylvatica*, the mid-dorsal stripe in *R. sylvatica* and *B. americanus*, and the predominance of green phases in *R. pipiens* and *P. triseriata*. This tendency doubtless is a consequence of selection by visual predators in the less forested northern habitat.

Acknowledgments

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Literature Cited

Ashton, R. E., Jr., S. I. Guttman, and **P. Buckley.** 1973. Notes on the distribution, coloration, and breeding of the Hudson Bay Toad, *Bufo americanus copei* (Yarrow and Henshaw). Journal of Herpetology 7: 17–20.

Bleakney, J. S. 1958. A zoogeographic study of the amphibians and reptiles of eastern Canada. National Museum of Canada, Bulletin 155: 1–119.

Bleakney, J. S. 1959. Postglacial dispersal of the Western Chorus Frog in eastern Canada. Canadian Field-Naturalist 73: 197–205.

Browder, L. W., J. C. Underhill, and **D. J. Merrell.** 1966. Mid-dorsal stripe in the Wood Frog. Journal of Heredity 57: 65–67.

Cook, F. R. 1964a. A northern range extension for *Bufo americanus* with notes on *B. americanus* and *Rana sylvatica*. Canadian Field-Naturailst 78: 65–66.

Cook, F. R. 1964b. Additional records and a correction of the type locality for the Boreal Chorus Frog in northwestern Ontario. Canadian Field-Naturalist 78: 186–192.

Cook, F. R. 1968. Reptiles and amphibians. *In* Science, history, and Hudson Bay. Volume 1. Beals, C. S. (*Editor*). Department of Energy, Mines and Resources, Ottawa. pp. 436–442.

Cott, H. B. 1940. Adaptive coloration in animals. Methuen and Company, London, England. 508 pp.

Fishbeck, D. W. and **J. C. Underhill.** 1971. Distribution of stripe polymorphism in Wood Frogs,

Rana sylvatica LeConte, from Minnesota. Copeia 1971: 253–259.

Gosner, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16: 183–190.

Greenwald, L. 1972. Sodium balance in amphibians from different habitats. Physiological Zoology 45: 229–237.

Herreid, C. F., II, and **S. Kinney.** 1967. Temperature and development of the Wood Frog, *Rana sylvatica,* in Alaska. Ecology 48: 579–590.

Johansen, K. 1962. Observation on the Wood Frog *Rana sylvatica* in Alaska. Ecology 43: 146–147.

Karlstrom, E. L. 1966. The Northwestern Toad *Bufo boreas boreas* in central Alaska — a study of an ectotherm at the northern limit of its species range. *In* Science in Alaska. Abstract from the 17th Alaskan Science Conference Proceedings. p. 64.

Lee, H. A. 1968. Quaternary Geology. *In* Science, history, and Hudson Bay. Volume 2. C. S. Beals (*editor*). Department of Energy, Mines and Resources, Ottawa. pp. 503–543.

Logier, E. B. S. and **G. C. Toner.** 1961. Checklist of the amphibians and reptiles of Canada and Alaska. Royal Ontario Museum Life Sciences Division, Contribution 53: 1–92.

Matthews, T. C. 1971. Genetic changes in a population of Boreal Chorus Frogs (*Pseudacris triseriata*) polymorphic for color. American Midland Naturalist 85: 208–221.

Matthews, T. C. and **D. Pettus.** 1966. Color inheritance in *Pseudacris triseriata.* Herpetologica 22: 269–275.

Martof, B. S. 1970. *Rana sylvatica.* Catalogue of American Amphibians and Reptiles 86.1-86.4.

Martof, B. S. and **R. L. Humphries.** 1959. Geographic variation in the Wood Frog *Rana sylvatica.* American Midland Naturalist 61: 350–389.

McCoy, C. J. and **C. J. Durden.** 1965. New distribution records of amphibians and reptiles in eastern Canada. Canadian Field-Naturalist 79: 156–157.

Moore, H. 1965. A mid-summer trip to Moosonee. The Wood Duck 19: 163–165.

Preble, E. A. 1902. A biological investigation of the Hudson Bay region. North American Fauna 22: 1–140.

Schmidt, R. S. 1968. Chuckle calls of the Leopard Frog (*Rana pipiens*).Copeia 1968: 561–569.

Turner, E. R. A. 1961. Survival values of different methods of camouflage as shown in a model population. Proceedings of the Zoological Society of London 136: 273–284.

Turner, F. B. 1959. Pigmentation of the Western Spotted Frog, *Rana p. pretiosa,* in Yellowstone Park, Wyoming. American Midland Natuarlist 61: 162–176.

Whitmore, D. R. E. and **B. A. Liberty.** 1968. Bedrock geology and mineral deposits. *In* Science, history, and Hudson Bay. Volume 2. C. S. Beals (*editor*). Department of Energy, Mines and Resources, Ottawa. pp. 543–557.

Wright, A. H. and **A. A. Wright.** 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Associates, Ithaca, New York. 640 pp.

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Studies on the Bryophytes of Southern Manitoba. V. Collections from Whiteshell Provincial Park

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Stringer, M. H. L. and P. W. Stringer. 1973. Studies on the bryophytes of southern Manitoba. V. Collections from Whiteshell Provincial Park. Canadian Field-Naturalist 87: 419-425.

Abstract. One hundred and twenty-nine taxa of bryophytes were collected in the western part of Whiteshell Provincial Park, Manitoba. The following eight taxa have not previously been recorded for the province: *Frullania bolanderi, Lophozia excisa, L. hatcheri, Porella platyphylloidea, Anomodon rostratus, Grimmia donniana, G. unicolor,* and *Hygroamblystegium fluviatile* var. *orthocladum.*

Introduction

Whiteshell Provincial Park lies in the southeastern corner of Manitoba, approximately 110 km from Winnipeg. Its eastern limit is on the Ontario border, and its southern boundary is approximately 70 km from the Manitoba–Minnesota border.

Although the area has been developed as a park since 1962, much of its 2703 km^2 is still inaccessible except by air, hiking trail, or portaged canoe. The numerous lakes (131 in all), many linked by the Winnipeg or Whiteshell Rivers, provide the major water routes, while some of the larger rock outcrops and most of the lakes provide suitable landing sites for helicopters or small bush aircraft.

The rather low pattern of relief of the area caused by the post-glacial deposition of lacustrine materials is somewhat modified by morainic ridges, fluvial terraces, and rock outcrops (Rowe 1959). These last (Figure 1), which are a very conspicuous feature of the park, are largely composed of the Precambrian gneisses of the southern edge of the Canadian Shield, and are mainly acidic though with some basic pockets. Some of the outcrops may reach considerable proportions, *e.g.* the Tie Creek Boulder Mosaic outcrop which is upwards of 9 acres (0.036 km^2) (Steinbring 1970).

The entire park falls within the Lower English River Section of the Boreal Forest Region (Rowe 1959). Much of the area is forested. White spruce (*Picea glauca*)[2] – balsam fir (*Abies balsamea*) forest is frequent on well-drained sites, sometimes with an admixture of paper birch (*Betula papyrifera*). Along the river valleys, mixed wood or mixed hardwood forest, frequently dominated by balsam poplar (*Populus balsamifera*), is of general occurrence, with aspen (*Populus tremuloides*) on the slopes. Jack pine forest (*Pinus banksiana*) is common on sandier soils, while low-lying, poorly-drained parts of the park have tracts of bog forest dominated by black spruce (*Picea mariana*) or tamarack (*Larix laricina*).

Little botanical work has been published on the park. The only published recordings of bryophytes are of three species new to the province reported by Longton (1972) for the controlled area of the Whiteshell Nuclear Research Establishment near the western boundary.

With the exception of site 11, the area covered in the present study lies within the western part of the park, in the region of Dorothy, Betula, and George lakes (Figure 2). Site 11 (49°49′ N, 95°16′ W) is in the southern part but is included in this publication as it had a number of species not recorded elsewhere in the park.

Twenty-eight sites were visited, chiefly in June and July 1972. Collections at sites 7, 13, 14, and 16 were made in August and September 1972. Voucher specimens have been deposited in the authors' own herbarium and at the University of Winnipeg.

[2]Vascular plant nomenclature follows Scoggan (1957).

FIGURE 1. Rock outcrop at George Lake, Whiteshell Provincial Park. Dominant tree species are white spruce and jack pine.

Bryophytes Collected

A total of 129 taxa were collected from Whiteshell Provincial Park; these are listed. Nomenclature of Sphagnobrya and Eubrya follows Crum et al. (1965), with modification according to Crum (1971). Hepatic nomenclature is based on Schuster (1953, 1966, 1969), with abbreviations of authorities modified to conform to the list given by Sayre et al. (1964). Nomenclature of Mniaceae follows Koponen (1968, 1971).

HEPATICAE

Chiloscyphus pallescens (Ehrh.) Dum.
Chiloscyphus polyanthus (L.) Corda
Frullania bolanderi Aust.
Frullania eboracensis Gott.
Frullania inflata Gott.
Jamesoniella autumnalis (DC.) Steph.
Lepidozia reptans (L.) Dum.
Lophocolea bidentata (L.) Dum.
Lophocolea heterophylla (Schrad.) Dum.
Lophocolea minor Nees
Lophozia barbata (Schmid.) Dum.
Lophozia excisa (Dicks.) Dum.
Lophozia hatcheri (Evans) Steph.
Lophozia kunzeana (Hüb.) Evans
Lophozia ventricosa (Dicks.) Dum.
Marchantia polymorpha L.
Plagiochila asplenioides (L.) Dum.
Porella platyphylla (L.) Lindb.
Porella platyphylloidea (Schwein.) Lindb.
Ptilidium ciliare (L.) Nees
Ptilidium pulcherrimum (Web.) Hampe
Radula complanata (L.) Dum.
Riccardia palmata (Hedw.) Carruth.
Riccardia pinguis (L.) S. Gray

SPHAGNOBRYA

Sphagnum capillaceum (Weiss) Schrank
Sphagnum capillaceum (Weiss) Schrank var. *tenellum* (Schimp.) Andr.
Sphagnum magellanicum Brid.
Sphagnum recurvum P. Beauv.
Sphagnum squarrosum Sw. *ex.* Crome

EUBRYA

Abietinella abietina (Hedw.) Fleisch.
Amblystegium juratzkanum Schimp.
Amblystegium serpens (Hedw.) B.S.G.

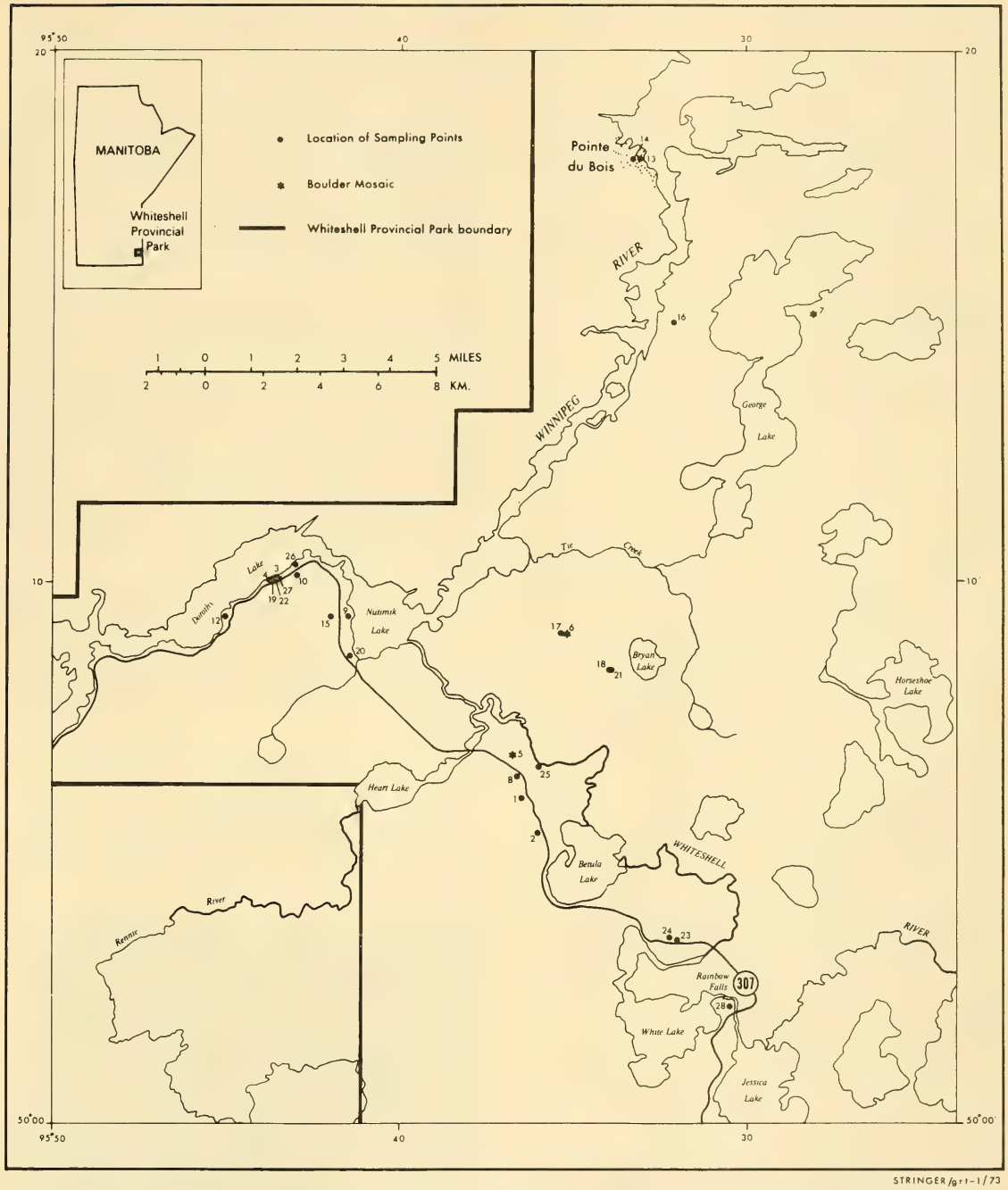

FIGURE 2. Western part of Whiteshell Provincial Park, showing bryophyte collecting sites 1–10, 12–28.

Amblystegium varium (Hedw.) Lindb.
Anomodon attenuatus (Hedw.) Hüb.
Anomodon rostratus (Hedw.) Schimp.
Aulacomnium palustre (Hedw.) Schwaegr.
Barbula convoluta Hedw.
Barbula unguiculata Hedw.
Bartramia pomiformis Hedw.
Brachythecium campestre (C. Müll.) B.S.G.

Brachythecium collinum (Schleich. *ex.* C. Müll.) B.S.G.
Brachythecium rivulare B.S.G.
Brachythecium rutabulum (Hedw.) B.S.G.
Brachythecium salebrosum (Web. and Mohr) B.S.G.
Brachythecium velutinum (Hedw.) B.S.G.
Bryoerythrophyllum recurvirostrum (Hedw.) Chen
Bryum angustirete Kindb. *ex* Mac.
Bryum caespiticium Hedw.
Bryum creberrimum Tayl.
Bryum pallescens Schleich. *ex* Schwaegr.
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer and Scherb.
Callicladium haldanianum (Grev.) Crum
Calliergon giganteum (Schimp.) Kindb.
Campylium chrysophyllum (Brid.) J. Lange
Campylium hispidulum (Brid.) Mitt.
Campylium stellatum (Hedw.) C. Jens.
Ceratodon purpureus (Hedw.) Brid.
Climacium dendroides (Hedw.) Web. and Mohr
Dicranella heteromalla (Hedw.) Schimp.
Dicranella schreberiana (Hedw.) Schimp.
Dicranum bonjeanii De Not. *ex* Lisa
Dicranum drummondii C. Müll.
Dicranum flagellare Hedw.
Dicranum fragilifolium Lindb.
Dicranum fuscescens Turn.
Dicranum montanum Hedw.
Dicranum polysetum Sw.
Dicranum scoparium Hedw.
Dicranum undulatum Brid.
Drepanocladus aduncus (Hedw.) Warnst.
Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. *ex* Voit) Roth
Drepanocladus fluitans (Hedw.) Warnst.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus vernicosus (Lindb. *ex* C. Hartm.) Warnst.
Encalypta ciliata Hedw.
Encalypta procera Bruch
Eurhynchium pulchellum (Hedw.) Jenn.
Funaria hygrometrica Hedw.
Grimmia alpicola Hedw.
Grimmia apocarpa Hedw.
Grimmia donniana Sm. *ex* Sm. and Sowerby
Grimmia unicolor Hook. *ex* Grev.
Haplocladium microphyllum (Hedw.) Broth.
Hedwigia ciliata (Hedw.) P. Beauv.
Hygroamblystegium fluviatile (Hedw.) Loeske var. *orthocladum* P. Beauv.
Hylocomium splendens (Hedw.) B.S.G.
Hypnum cupressiforme Hedw.
Hypnum lindbergii Mitt.
Hypnum pallescens (Hedw.) P. Beauv.
Hypnum pratense Koch *ex* Spruce
Isopterygium turfaceum (Lindb.) Lindb.
Leptobryum pyriforme (Hedw.) Wils.
Leptodictyum riparium (Hedw.) Warnst.
Leptodictyum trichopodium (Schultz) Warnst.
Leptodictyum trichopodium (Schultz) Warnst. var. *kochii* (B.S.G.) Broth.
Leskea polycarpa Hedw.
Leskeela nervosa (Brid.) Loeske
Leucobryum glaucum (Hedw.) Angstr. *ex* Fr.
Mnium spinulosum B.S.G.
Neckera pennata Hedw.
Oncophorus wahlenbergii Brid.
Orthotrichum obtusifolium Brid.
Orthotrichum speciosum Nees *ex* Sturm
Paraleucobryum longifolium (Hedw.) Loeske
Plagiomnium cuspidatum (Hedw.) Kop.
Plagiomnium drummondii (Bruch and Schimp.) Kop.
Plagiomnium rugicum (Laur.) Kop.
Plagiothecium denticulatum (Hedw.) B.S.G.
Platydictya subtile (Hedw.) Crum
Platygyrium repens (Brid.) B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. and Mohr) Andr.
Polytrichum commune Hedw.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Ptilium crista-castrensis (Hedw.) De Not.
Pylaisiella polyantha (Hedw.) Grout
Rhodobryum roseum (Hedw.) Limpr.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Tetraphis pellucida Hedw.
Tetraplodon mnioides (Hedw.) B.S.G.
Thuidium delicatulum (Hedw.) B.S..G
Thuidium delicatulum (Hedw.) B.S.G. var. *radicans* Crum, Steere and Anderson
Thuidium recognitum (Hedw.) Lindb.
Tomenthypnum nitens (Hedw.) Loeske
Tortula mucronifolia Schwaegr.
Tortula ruralis (Hedw.) Gaertn., Meyer and Scherb.

A detailed annotated list of species is available at a nominal charge from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

Bryophyte Habitat Relations

Several rock outcrops (sites 1–7, Figure 2) were searched for bryophytes. Of these, some were open with little vascular plant cover (1,

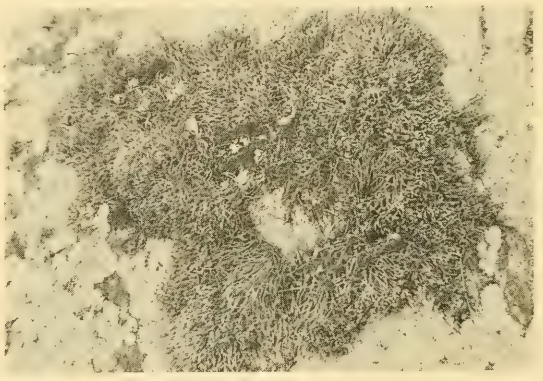

FIGURE 3. *Hedwigia ciliata* on a rock outcrop near Dorothy Lake, Whiteshell Provincial Park. Several large patches of lichen are also present.

3, 4, 5), while some had moist fissures, wet hollows, or moist shaded faces (2, 4, 7). Sites 2 and 7 had forested depressions.

On bare rock or rock with little cover of humus or soil, *Hedwigia ciliata* was common and often abundant (Figure 3). Small patches of *Grimmia apocarpa* were also frequent. Both these saxicolous species were quite common on erratic boulders in forested areas as well as on rock outcrops.

Where humus had accumulated over the rock, several large acrocarps were present, often in abundance, *e.g. Dicranum scoparium, D. polysetum, D. drummondii, Polytrichum juniperinum,* and *Plagiomnium cuspidatum,* along with the pleurocarpous species *Pleurozium schreberi, Eurhynchium pulchellum, Ptilium crista-castrensis, Brachythecium campestre,* and, less frequently, *Plagiothecium denticulatum.*

In the moister rock hollows, light greenish-yellow patches of *Aulacomnium palustre* were conspicuous, while vivid green tufts of *Bartramia pomiformis* could be seen on humus in cracks or hollows in the rock surface. One very large cushion of *Leucobryum glaucum,* a species of wet, acid habitats, was found in a moist hollow at site 7. The only previous report of *L. glaucum* in the prairie provinces was by Lowe (1943) for southeastern Manitoba.

Neckera pennata, a species usually found on trunks of deciduous trees, but also found on rock ledges and cliffs in the eastern part of Canada and the United States, was very abundant on moist, vertical rock faces at site 4.

On pockets of mineral soil in the rock, *Polytrichum piliferum* was common.

Liverworts were frequent on thin layers of humus and plant litter over the rocks. *Lophozia excisa, L. barbata,* and *Ptilidium pulcherrimum* were especially common. On bare rock faces, reddish-brown colonies of *Frullania eboracensis* were not infrequent. This species, a pioneer on both bark and rock (Schuster 1957), was also found on bark of live trees in white spruce – balsam fir forests where it was often associated with *Radula complanata* and probably represented part of the *Frullania – Radula – Porella* Associule as described by Schuster (1957).

Collections were also made in jack pine forests (sites 8–11), some of which had moist depressions (8), a considerable amount of deadfall (10), or erratic boulders (8, 10, 11).

Here hepatics were much less abundant, *Ptilidium pulcherrimum* being the only species collected with any degree of frequency. This species was usually found on rotten wood and formed part of the bryophytic communities on deadfall in most types of forested sites. Other species typically growing on wood in advanced stages of decay included *Lophocolea heterophylla, Callicladium haldanianum, Dicranum flagellare, D. montanum, D. fragilifolium, Oncophorus wahlenbergii, Hypnum pallescens,* and *Pohlia nutans. Pylaisiella polyantha,* a very common species of tree bases at most sites, was sometimes also part of these rotten wood colonies.

Ground cover of moss in jack pine-dominated forests was usually abundant, consisting largely of *Dicranum polysetum, D. drummondii, Pleurozium schreberi, Polytrichum juniperinum, P. commune,* and *Brachythecium salebrosum.*

On open patches of mineral soil, *Ceratodon purpureus* and *Polytrichum piliferum* were often present.

Of the white spruce-dominated forests (sites 12–20), some had an admixture of balsam fir (12, 17, 18, 19), some balsam poplar (13), some jack pine (19), paper birch (17, 20), and aspen (12). They varied from mesic (12) to wet (19). Sites 14 and 20 were disturbed.

White spruce-dominated forests were rich in bryophytes. Hepatics were common, and included most of the species prominent on rock outcrops. *Radula complanata* was frequent on rotten wood as well as on live bark, while *Frullania inflata,* previously reported only for the Winnipeg area (Stringer and Stringer 1973) was found on humus over an erratic boulder at site 16.

Besides the other common species of rotten wood, *Haplocladium microphyllum, Campylium hispidulum,* and *Isopterygium turfaceum* could be found on well-rotted logs in the white spruce forests.

In the more mesic sites of this group, ground-cover dominants were essentially those of the

jack pine forests, with *Dicranum scoparium, Plagiomnium cuspidatum, Hylocomium splendens,* and *Eurhynchium pulchellum* also prominent. *Plagiomnium cuspidatum* was sometimes found on rotten wood. *Abietinella abietina,* as well as forming part of the ground cover at several sites, was also a conspicuous component of the tree stockings at site 16 where it occurred up to 0.5 m above ground level.

In the wetter white spruce forests, *Climacium dendroides, Thuidium recognitum, Thuidium delicatulum* var. *radicans,* and *Brachythecium rutabulum* constituted an appreciable proportion of the ground cover.

It was impossible to inspect very wet forested areas and marshes thoroughly as they remained flooded and inaccessible throughout the season. However, some collections were made at sites 21–23 (black spruce bog forest) and 24 (tamarack). Sites 25–28 were non-forested wet areas such as *Carex* or *Carex–Equisetum* marshes, and rocks, gravel, mud and moist earth along the banks of the White-shell River.

The most prominent bryophytes of the bog forest floors were *Sphagnum* species, including *S. capillaceum, S. capillaceum* var. *tenellum, S. magellanicum,* and *S. recurvum.* These often formed large hummocks. *Pleurozium schreberi* was still a common species at sites 23 and 24.

A number of other typically wetland species were abundant at some of the waterlogged sites. These included *Aulacomnium palustre, Calliergon giganteum, Campylium stellatum, Tomenthypnum nitens, Leptodictyum riparium, Drepanocladus aduncus, D. fluitans,* and *D. vernicosus.*

New Records and Notes on Distribution

A number of species seemed to be strictly or predominantly eastern or eastern-central in their distribution. These included several species common in the study area, i.e. *Dicranum montanum, D. flagellare, D. drummondii, Callicladium haldanianum, Isopterygium turfaceum,* and *Thuidium delicatulum* var. *radicans.*

Eight species had not previouly been recorded for the province, *i.e. Frullania bolanderi, Lophozia excisa, L. hatcheri, Porella platyphylloidea, Anomodon rostratus, Grimmia donniana, G. unicolor,* and *Hygroamblystegium fluviatile* var. *orthocladum.*

A single collection of *Frullania bolanderi* was made on a shaded, east-facing rock face at site 4. Although usually considered a pioneer on bark, this species may also be a pioneer on rock surfaces (Schuster 1953). According to Schuster (1958), it is a Pacific Coast Lowland species recurring as a disjunct in the Great Lakes region. The present recording appears to be a northwestern extension of its distribution in the Great Lakes area.

Lophozia excisa, a pioneer on rocks of widely varied pH (Schuster 1969), appears to fall within its known range. Recordings have been made in Alberta (Bird 1966) and Minnesota (Schuster 1969).

Lophozia hatcheri, characteristic of the upper edge of the boreal forest and the lower edge of the tundra (Schuster 1953), is here near the southern limit of its range.

No recordings of *Porella platyphylloidea* have been made for any of the prairie provinces (Bird 1966), although Crowe and Barclay-Estrup (1971) have reported it from the Lake Superior region. According to Schuster (1953), it is common in Minnesota but of restricted occurrence westwards and in the extreme northeast. The present recording thus extends its known northwestern distribution.

The only collection of *Anomodon rostratus* was made on moss litter and thick humus at the wet base of a vertical rock face at site 11. According to Grout (1934, page 73), it is very common in the northeastern United States and eastern Canada and has been reported from Vancouver Island by Macoun. It has not, however, been reported for any of the prairie provinces (Bird 1966).

Grimmia donniana and *G. unicolor,* saxicolous species, were both found at site 5. *Grimmia donniana* has been recorded for Alberta but *G. unicolor* has not previously been recorded for any of the prairie provinces (Bird 1966).

Hygroamblystegium fluviatile var. *orthocladum* was abundant as thick, fine mats on silt over rocks at site 25. It appears to fall within

the known range of the taxon given by Grout (1934) as *H. orthocladum*. Bird (1969) reported the species f om the Roseau River, 13 km south of St. Malmo, Manitoba. No other reports for either the species or the variety exist for west-central Canada (Bird 1966).

Acknowledgments

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Literature Cited

Bird, C. D. 1966. A catalogue of the bryophytes reported from Alberta, Saskatchewan, and Manitoba. Processed publication, University of Calgary, Calgary, Alberta.

Bird, C. D. 1969. Bryophytes of the aspen parkland of west-central Canada. Canadian Journal of Botany 47(1): 187–212.

Crowe, J. M. and **P. Barclay-Estrup.** 1971. A checklist of the hepatics in the area adjacent to the Canadian Lakehead. The Bryologist 74: 36–39.

Crum, H. 1971. Nomenclatural changes in the Musci. The Bryologist 74: 165–174.

Crum, H., W. C. Steere, and **L. E. Anderson.** 1965. A list of the mosses of North America. The Bryologist 68: 377–434.

Grout, A. J. 1934. Moss flora of North America north of Mexico. Volume III. Published by the author, Newfane, Vermont.

Koponen, T. 1968. Generic revision of Mniaceae Mitt. (Bryophyta). Annales Botanici Fennici 5: 117–151.

Koponen, T. 1971. A monograph of *Plagiomnium* sect. Rosulata (Mniaceae). Annales Botanici Fennici 8: 305–367.

Lowe, C. W. 1943. List of flowering plants, ferns, club mosses, mosses and liverworts of Manitoba. Processed publication, Natural History Society of Manitoba, Winnipeg, Manitoba.

Longton, R. E. 1972. Nineteen bryophytes new to Manitoba. The Bryologist 75: 348–350.

Rowe, J. S. 1959. The forest regions of Canada. Bulletin 123 Canada Department of Northern Affairs and National Resources, Forestry Branch, Ottawa, Ontario.

Sayre, G., C. E. B. Bonner, and **W. L. Culberson.** 1964. The authorities for the epithets of mosses, hepatics and lichens. The Bryologist 67: 113–135.

Schuster, R. M. 1953. Boreal Hepaticae. A manual of the liverworts of Minnesota and adjacent regions. The American Midland Naturalist 49(2): i–v, 257–684.

Schuster, R. M. 1957. Boreal Hepaticae. A manual of the liverworts of Minnesota and adjacent regions. II. Ecology. The American Midland Naturalist 57(1–2): 203–299.

Schuster, R. M. 1958. Notes on nearctic Hepaticae. VI. Phytogeographic relationships of certain critical species in Minnesota and adjacent regions of the Great Lakes. Rhodora 60: 209–256.

Schuster, R. M. 1966. The Hepaticae and Anthocerotae of North America east of the Hundredth Meridian. Volume I. Columbia University Press, New York. 802 pp.

Schuster, R. M. 1969. The Hepaticae and Anthocerotae of North America east of the Hundredth Meridian. Volume II. Columbia University Press, New York. 1062 pp.

Scoggan, H. J. 1957. Flora of Manitoba. Bulletin 140, National Museum of Canada, Ottawa, Ontario.

Steinbring, J. H. 1970. The Tie Creek boulder site of southeastern Manitoba. *In* Ten thousand years. Archaeology in Manitoba. Edited by W. M. Hlady. Manitoba Archaeological Society, Winnipeg, Manitoba. pp. 223–268.

Stringer, M. H. L., and **P. W. Stringer.** 1973. Studies on the bryophytes of southern Manitoba. II. Collections from the Winnipeg area. Canadian Field-Naturalist 87: 141–144.

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Great Blue Heron and Double-crested Cormorant Colonies in the Prairie Provinces

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Vermeer, K. 1973. Great Blue Heron and Double-crested Cormorant colonies in the prairie provinces. Canadian Field-Naturalist 87: 427-432.

Abstract. Breeding populations of Great Blue Herons and Double-crested Cormorants were estimated to consist of 4,000 and 6,500 pairs, respectively, on the basis of surveys in the Canadian prairie provinces during 1967–1972. Most Great Blue Herons bred predominantly in trees and most Double-crested Cormorants nested on the ground on lake islands. The breeding ranges of Great Blue Herons and Double-crested Cormorants were similar. Highest nesting densities were found in the Lake Manitoba–Lake Winnipegosis region where there is an abundant food supply.

Introduction

Surveys of colonies of Great Blue Herons (*Ardea herodias*) were conducted in Alberta in 1967 (Vermeer 1969a), in Saskatchewan in 1970 (Vermeer and Anweiler 1970), and in Manitoba in 1969 (Vermeer 1970a) and in 1971 (Vermeer and Hatch 1972). Double-crested Cormorant (*Phalacrocorax auritus*) colonies were surveyed in Alberta in 1967 (Vermeer 1969b), in Saskatchewan in 1968 (Vermeer 1970b), and in Manitoba in 1969 (Vermeer 1969c). The methods of conducting the surveys were described in the above-mentioned papers. Additional information has been collected for the two species in the prairie provinces and it now is possible to compare population, nest location, and breeding range of Great Blue Herons and Double-crested Cormorants in Alberta, Saskatchewan, and Manitoba. In calculating the total nesting population for the two species, a possible bias may have been introduced by adding colonies discovered in subsequent years (Tables 1 and 4) to those found during the main surveys, as colonial birds are known to shift breeding sites within the same region. However, a greater bias may arise by omitting those additional colonies from the population estimate as most of them could have been overlooked initially.

Results

Great Blue Herons

The 14 heronries found in Alberta since 1967, and one heronry found in Manitoba since 1971, are shown in Table 1. The heronries on the islands in Whitefish Lake, and in a pond near Dowling Lake and along Ross Creek (Table 1), are known to have been established after 1967. One insular heronry at Dowling Lake disappeared in 1969 as a result of human disturbance. The herons probably moved 3 miles from there to the pond adjacent to that lake (Table 1).

The heronry at the present location on an island in Beaver Lake (Table 1) was established in 1971 or 1972. Herons bred at that lake in 1970 on an island 5 miles from the 1972 site. Human disturbance is not thought to be the cause of the relocation, but the presence of a nesting pair of Bald Eagles (*Haliaeetus leucocephalus*) in the deserted heronry in 1972 (eagles were not there in 1970) may have driven the herons away.

A total of 123 active heronries with 3,764 nests were found in Alberta, Saskatchewan, and Manitoba during the 1967–1972 period. On the basis of that figure and considering that heronries continued to be found after the initial survey, it is estimated that the total breed-

TABLE 1. — Additional active Great Blue Heron colonies observed in Alberta since 1967, and Manitoba since 1971

Colony location	Number of nests	Latitude	Longitude	Year observed
Alberta				
Beaver Lake	30	54°43′ N	111°53′ W	1972
Bow River	20	50°46′ N	113°04′ W	1972
Bow River	10	49°49′ N	111°35′ W	1972
Island Lake	1	54°20′ N	112°25′ W	1972
Lac Canard	40	53°53′ N	111°21′ W	1972
Little Red Deer River	18	51°48′ N	114°25′ W	1972
Majeau Lake	20	53°55′ N	114°25′ W	1969
North Buck Lake	5	54°41′ N	112°32′ W	1972
Pond near Dowling Lake	20	51°43′ N	112°04′ W	1972
Pond in Elk Island National Park	9	53°39′ N	112°52′ W	1971
Ross Creek	25	49°58′ N	110°20′ W	1972
Sheep River	25	50°40′ N	114°16′ W	1969
Whitefish Lake	2	54°22′ Y	111°56′ W	1972
Lower Mann Lake	1	54°10′ N	111°30′ W	1972
Manitoba				
Swan Lake	125	52°35′ N	100°47′ W	1972

ing population of Great Blue Herons in the region for that period consisted of at least 4,000 breeding pairs.

The heronries averaged 31 nests and ranged from 1 to 170 nests (Table 2). Eight heronries in Manitoba contained more than 75 nests each, but no heronries with more than 75 nests were found in either Alberta or Saskatchewan. Most of the larger Manitoba heronries were found in the Lake Manitoba – Winnipegosis region (Figure 1), on Lake Manitoba, Lake Winnipegosis, and adjacent Waterhen, Pelican, and Swan Lakes. The mean colony size and the 95% confidence interval of 16 colonies in the Lake Manitoba – Lake Winnipegosis area was 70.5 ± 27.8 nests, which is significantly larger in size than any of the 37 colonies outside that region which contained only 27.7 ± 6.3 nests. Significantly, the Lake Manitoba – Lake Winnipegosis region contained 30% of the total

TABLE 2. — Comparison of the size of active Great Blue Heron colonies in the Canadian prairie provinces, 1967–1972

Provinces	No. colonies	Mean colony size ± 95% confidence interval	Range in colony size
Alberta	39	19.9±4.3	1–55
Saskatchewan	31	26.8±8.1	1–75
Manitoba	53	40.6±10.2	3–170
All three provinces	123	30.6±5.3	1–170

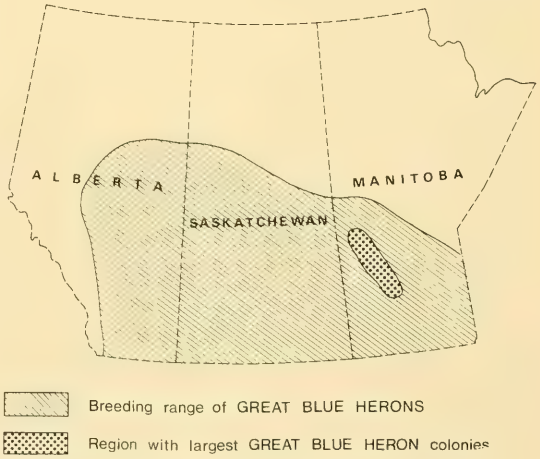

FIGURE 1. Breeding range of Great Blue Herons in the Canadian prairie provinces.

breeding population of Great Blue Herons in the Canadian prairie provinces.

All heronries were located near water on a stream, pond, or lake, and almost half of them were on islands in lakes (Table 3). All but two of the 123 colonies were in trees. Two small heronries on the ground were on treeless islands where the herons nested in association with White Pelicans (*Pelecanus erythrorhynchos*), Double-crested Cormorants, Herring Gulls (*Larus argentatus*), Ring-billed Gulls (*Larus delawarensis*), Caspian Terns (*Hydroprogne caspia*), and Common Terns (*Sterna hirundo*).

TABLE 3. — Nest location of active Great Blue Heron colonies in the Canadian prairie provinces, 1967–1972

Provinces	Number of nests			
	Near rivers, creeks, lakes, and ponds	On lake islands	In trees	On the ground
Alberta	19	20	39	0
Saskatchewan	19	12	31	0
Manitoba	27	26	51	2
All three provinces	65	58	121	2

The breeding range of the Great Blue Heron in the Canadian prairie provinces is shown in Figure 1. The following peripheral colonies roughly define the western and northern boundaries of their breeding range: Belly River (49°18′ N, 113°33′ W), Sheep River (50°40′ N, 114°16′ W), Beaverdam Creek (51°24′ N, 114°22′ W), and Chip Lake (53°40′ N, 115°26′ W) in western Alberta; Pelican Lake (55°49′ N, 113°15′ W) in northern Alberta; Churchill Lake (55°59′ N, 108°16′ W) and Suggi Lake (54°21′ N, 102°49′ W) in central Saskatchewan; Talbot Lake (54°07′ N, 99°53′ W) and Many Bays Lake (52°40′ N, 97°00′ W) in central Manitoba. The northern boundary shown in Figure 1 is considerably north of the one given for Saskatchewan and Manitoba by Godfrey (1966).

Double-crested Cormorants

Fifty-six active Double-crested Cormorant colonies with 6,397 nests were found in Alberta, Saskatchewan, and Manitoba during the 1967–1972 period. The six colonies found in the Canadian prairie provinces since the 1967–1969 surveys are shown in Table 4. In addition there were two colonies in Alberta that had increased in size since the 1967 survey. They were at Newell Reservoir (50°24′ N, 111°58′ W) with 232 nests in 1969, and at Lower Therien Lake (53°54′ N, 111°23′ W) with 57 nests in 1972.

Inasmuch as cormorant colonies are much more restricted to lake islands (Table 5) and

TABLE 4. — Additional active Double-crested Cormorant colonies observed in the Canadian prairie provinces since 1967–1969

Colony location	Number of nests	Latitude	Longitude	Year observed
Utikuma Lake, Alberta	6	55°55′ N	115°23′ W	1970
Cumberland Lake, Saskatchewan	13	54°07′ N	102°18′ W	1970
Junction Reservoir, Saskatchewan*	105	49°58′ N	109°30′ W	1972
Pond in Turtle Mountains, Manitoba	11	49°01′ N	100°03′ W	1971
Stewart Lake, Manitoba	14	50°38′ N	100°15′ W	1971
Swan Lake, Manitoba	30	52°33′ N	100°47′ W	1972

*Discovered by A. R. Smith (Personal communication).

as a consequence are easier to find than heronries, it is believed that few colonies were missed in the surveys. On the basis of the 6,397 nests counted, it is estimated that the total breeding population of Double-crested Cormorants in the Canadian prairie provinces for the 1967–1972 period consisted of 6,500 breeding pairs. The colonies averaged 114 nests and ranged from 2 to 1,010 nests (Table 6). Although the Manitoba colonies did not differ significantly in size from those in Alberta or Saskatchewan, the three largest colonies, with 645, 802, and 1,010 nests, were found in the Lake Manitoba – Lake Winnipegosis region (Figure 2). That region contained 54.9% of the total breeding population of Double-crested Cormorants in the area surveyed.

TABLE 5. — Nest location of active Double-crested Cormorant colonies in the Canadian prairie provinces, 1967–1972

Provinces	Number of nests			
	Near lakes and ponds	On lake islands	In trees	On the ground
Alberta	0	4	0	4
Saskatchewan	0	12	1	11
Manitoba	4	36	6	34
All three provinces	4	52	7	49

TABLE 6. — Comparison of the size of active Double-crested Cormorant colonies in the Canadian prairie provinces, 1967–1972

Provinces	Number of colonies	Mean colony size ± 95% confidence interval	Range in colony size
Alberta	4	98.1±58.1	2–232
Saskatchewan	12		4–434
Manitoba	40	120.7±68.3	3–1010
All three provinces	56	114.2±51.0	2–1010

The large majority of the cormorants nested on the ground on islands in lakes (Table 5). At three of the six places where they nested in trees, they were associated with Great Blue Herons. On treeless islands in lakes, cormorants always nested in association with gulls, either California Gulls (*Larus californicus*), Herring gulls, or Ring-billed Gulls and also frequently with White Pelicans, Common Terns or Caspian Terns.

The breeding range of the Double-crested Cormorant in the Canadian prairie provinces is shown in Figure 2. The following active peripheral colonies define the western and northern boundaries: Newell Reservoir (50°24′ N, 111°58′ W) and Utikuma Lake (55°55′ N, 115°23′ W) in Alberta; Churchill Lake (55°59′ N, 108°16′ W) and Suggi Lake (54°21′ N, 102°49′ W) in central Saskatchewan; Moose Lake (54°09′ N, 100°04′ W) and Lake Winnipeg (52°59′ N, 97°32′ W) in central Manitoba.

Discussion

Disturbance to Populations

There were 2,500 more breeding pairs of cormorants than herons in the Canadian prairie provinces. But cormorants were more vulner-

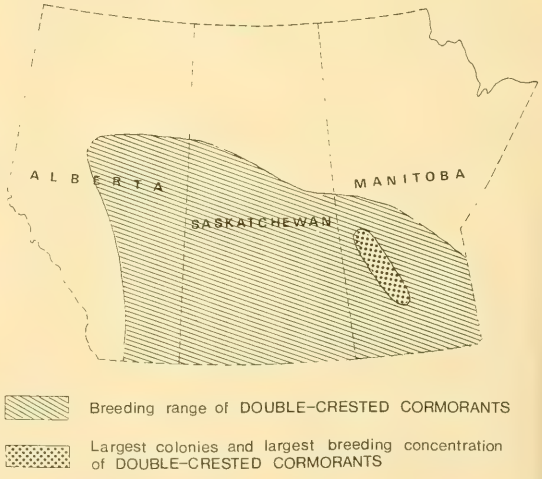

FIGURE 2. Breeding range of Double-crested Cormorants in the Canadian prairie provinces.

able to human disturbance because of their more restricted nesting habits (cf. Tables 3 and 5). In Alberta heronries which disappeared because of vandalism, decaying nesting trees (Vermeer 1969a), or other factors were often relocated within 10 miles of the original site. On the other hand, many cormorant colonies which disappeared from Alberta and Saskatchewan over the years because of human disturbance and falling lake levels (Houston 1962; Vermeer 1969b, 1970b) were not found again. The effects of human disturbance may be exemplified by the cormorant colonies of Lake Winnipegosis that declined from 9,862 nests in 1945 to 4,656 nests in 1951 and 1,403 nests in 1969 as a result of large scale destruction of eggs and young birds by people (McLeod and Bondar 1953; Vermeer 1969c).

Nesting Habitat

Great Blue Herons and Double-crested Cormorants nest in trees and on islands presumably to escape mammalian predators. In Alberta, California Gulls and Canada Geese (*Branta canadensis*) nesting on peninsulas and on islands separated from the mainland by very shallow water channels have been observed to be subject to extensive predation by coyotes (Vermeer 1970c, 1970d).

Ninety-eight percent of the Great Blue Herons nested in trees (Table 3) while 88% of the Double-crested Cormorants bred on the ground (Table 6). These different preferences may result from heron feet being better adapted for perching in trees than the totipalmate feet of cormorants.

Cormorants nested in trees in the Canadian prairie provinces only when there were no treeless islands in the vicinity.

That cormorants prefer to nest on the ground is also supported by observations that cormorants started to nest in trees after their former ground nesting habitat was disturbed by people (Lewis 1929) or became part of the mainland (Vermeer 1969c).

Breeding Range

The northern boundaries of the breeding ranges of cormorants and herons in Saskatchewan and Manitoba approximately coincide with the southern boundary of the Canadian Shield (Figures 1 and 2) although small cormorant and heron colonies have been found in the Manitoba and Ontario Shield areas. One such cormorant colony of 36 nests was found in 1912 by Todd at the southern end of James Bay (Lewis 1929). Though the Shield lakes produce fewer fish, probably as a result of a smaller quantity of dissolved nutrients (Rawson 1941, 1951; R. J. Paterson, fishery biologist, Winnipeg, personal communication), that restriction does not explain why cormorants and herons do not breed farther north in Alberta.

The largest colonies and the densest concentrations of breeding cormorants and herons were found in the Lake Manitoba – Lake Winnipegosis region (Figures 1 and 2). Thirty-seven percent of the breeding population of the White Pelicans in Canada was also found there (Vermeer 1970e). Such a large breeding concentration of colonial fish-eating birds in that region may be related to an abundant supply of fish. McLeod and Bondar (1953, p. 2) report of Lake Winnipegosis: "It is a heavy producer of fish, mostly of the anadromous type." The Saskatchewan-Nelson Basin Board report (1972) proposed diversions of water from the Saskatchewan River through Lake Winnipegosis and Lake Manitoba to the Assiniboine River. If those schemes are ever carried through, polluted Saskatchewan River water would be allowed to enter Lakes Winnipegosis and Manitoba, perhaps to the detriment of the fish populations and the fish-eating birds.

Literature Cited

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada. Bulletin 203. Biological Series 73. 428 pp.

Houston, C. S. 1962. Hazards faced by colonial birds. Blue Jay 20: 74–77.

Lewis, H. F. 1929. The natural history of the Double-crested Cormorant (*Phalacrocorax auritus auritus* L.). Ru-Mi-Lou Books, Ottawa. 94 pp.

McLeod, J. A. and **G. F. Bondar.** 1953. A brief study of the Double-crested Cormorant on Lake Winnipegosis. Canadian Field-Naturalist 67: 1–11.

Rawson, D. S. 1941. Soils as a primary influence in the biological productivity of lakes. Transactions

of the Canadian Conservation Association. pp. 78–87.

Rawson, D. S. 1951. The total mineral content of lake waters. Ecology 32: 669–672.

Saskatchewan-Nelson Basin Board. 1972. Water supply for the Saskatchewan-Nelson Basin. A summary report 1972. Information Canada, Ottawa. 57 pp.

Vermeer, K. 1969a. Great Blue Heron colonies in Alberta. Canadian Field-Naturalist 83: 237–242.

Vermeer, K. 1969b. Colonies of Double-crested Cormorants and White Pelicans in Alberta. Canadian Field-Naturalist 83: 36–39.

Vermeer, K. 1969c. The present status of Double-crested Cormorant colonies in Manitoba. Blue Jay 27: 217–220.

Vermeer, K. 1970a. Insular Great Blue Heron colonies on large Manitoba lakes. Blue Jay 28: 84–86.

Vermeer, K. 1970b. Colonies of Double-crested Cormorants and White Pelicans in Saskatchewan. Canadian Field-Naturalist 84: 39–42.

Vermeer, K. 1970c. Breeding biology of California and Ring-billed Gulls: A study of ecological adaptation to the inland habitat. Canadian Wildlife Service Series 12. 52 pp.

Vermeer, K. 1970d. A study of Canada Geese (*Branta canadensis*) nesting on islands in southeastern Alberta. Canadian Journal of Zoology 48: 235–240.

Vermeer, K. 1970e. Distribution and size of colonies of White Pelicans, *Pelecanus erythrorhynchos*, in Canada. Canadian Journal of Zoology 48: 1029–1032.

Vermeer, K. and **G. G. Anweiler.** 1970. Great Blue Heron colonies in Saskatchewan in 1970. Blue Jay 28: 158–161.

Vermeer, K. and **D. R. M. Hatch.** 1972. Additional information on Great Blue Heron colonies in Manitoba. Blue Jay 30: 89–92.

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The Chilcotin River Bighorn Population

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Demarchi, D. A. and H. B. Mitchell. 1973. The Chilcotin River bighorn population. Canadian Field-Naturalist 87: 433-454.

Abstract. The population dynamics and biology of the California bighorn sheep (*Ovis canadensis californiana*) occurring in the Chilcotin River area are documented. The grassland ecology is related to historical records and present grazing by domestic cattle and bighorn sheep. The area of the bighorn sheep range has been used by horses since the first white explorers visited the area, and for the past 100 years the area has been used to graze domestic livestock. The grasslands have ultimately been overgrazed and a community of needle-and-thread grass and sandberg bluegrass occurs over most of the area that could support a climax community of bluebunch wheatgrass and sandberg bluegrass. The use of particular terraces, gulleys, and cliffs is given in detail for bighorn sheep and cattle. During the winter of 1968–69, the deep snows coupled with the over-grazed ranges caused an abnormal reduction in bighorn sheep: rams were reduced from 80 to 50 animals, ewes from 200 to 140 animals, and lambs from 81 to 35 animals. There has been some population recruitment since that time, but the number of observed animals is lower than in the summer of 1968.

Introduction

California bighorn sheep (*Ovis canadensis californiana*) once ranged from the Sierra Nevadas of California, north through the Cascade Mountains of eastern Oregon and Washington and southern British Columbia, and on the east slope of the Coast Mountains between 50° and 52° north latitude (Cowan 1940). Early in the twentieth century until 1954, these sheep had become extinct over most of their range and had survived mainly in British Columbia, with only a small indigenous population in California (Buechner 1960).

Since 1954 there has been a notable increase in the California bighorn populations. Sugden (1961) reported the number of the California bighorn to be 1,235 in British Columbia and 550 in the United States. Spalding and Mitchell (1970) estimated that there were 3,000 California bighorn sheep in North America in 1968. Some states have reported herd increases since 1969. We estimate that there are presently 3,200 California bighorn sheep. Approximately 1,890 are found in British Columbia and most of those are indigenous populations. Introductions from the Chilcotin River bighorn populations into six American States, plus the indigenous California population, bring the known total sheep population in the United States to approximately 1,338 animals, distributed as follows: California 400, Oregon 210, Washington 500, North Dakota 120, Idaho 100, Nevada 8 (introduced from Oregon in 1968). In addition, 93 rams with a horn curl of 75% or better have been harvested in Washington, Oregon, and Idaho from the introduced herds. Consequently, the Chilcotin River population has proved to be vital to the survival and re-establishment of the California bighorn, with 42% of all present animals originating from the Chilcotin River stock.

Competition from domestic stock and land alienation on the winter ranges are problems that must be resolved for all existing herds including the Chilcotin River bighorn herd. The absence of realistic domestic stock grazing regulations, complicated by scattered private ownership over most of the range, presents a current problem in managing bighorn sheep winter ranges. On the Chilcotin River bighorn range there appears to be little competition of bighorn with other big game species; only a few mule deer are present during the winter.

Buechner (1960) stated, "Bighorn sheep are dependent more on vegetation than on any other component of their environment. Populations can recover from epizootic mortalities, either natural or induced from domestic stock,

if the vegetation is in sufficiently good condition to support the adults in good health and to permit successful reproduction and survival." Bighorn sheep, however, are traditional animals with little ability to adapt and pioneer other ranges, regardless of forage condition (Geist 1971). Unlike other native populations of California bighorn sheep in British Columbia and California that migrate from a summer range to a winter range, the Chilcotin River bighorn do not exhibit this tendency to migrate seasonally (Spalding and Bone 1969; Sugden 1961; Blood 1961; McCullough and Schneegas 1966). Since the Chilcotin bighorn range must support the bighorn sheep all year, forage abundance is extremely important for survival.

Except for one small increasing population occurring to the northwest in the Ilgachuz Mountains (Spalding and Mitchell 1970), the Chilcotin River bighorn population represents the northernmost major California bighorn sheep population. The Churn Creek herd winters 15 miles to the south on the west side of the Fraser River. These bighorn migrate southward into the Coast Range in the summer (Sugden 1961). One other California bighorn population occurs immediately south of the Chilcotin River herd, inhabiting the east side of the Fraser River from Dog Creek to Alkali Creek, between 3 and 15 miles south of the Chilcotin River herd. The Dog Creek herd was once a native herd, but in the 1950's bighorn from the northern Chilcotin River herd were transplanted here to increase the population.

The objective of the present report was to collate the data on existing Chilcotin River bighorn sheep and the range. The range data, collected in 1968, was part of a Master of Science research study at the University of Idaho by the senior author. The objective of the range study was to determine the successional stages of the *Agropyron/Poa* community as related to grazing pressure. During that study casual observations were made on the distribution and abundance of the bighorn sheep and livestock. As more objective population data was required for the management of the bighorn sheep, a separate study was undertaken to classify the bighorn sheep and to observe seasonal variations in their numbers over a 4-year period.

Methods

Vegetation Sampling

Seventeen sites in grassland communities were studied intensively using the macroplot technique of Poulton and Tisdale (1961). The macroplots were modified from 30 by 100 feet to 15 by 30 meters with five parallel, randomly selected, 15-meter transects located in each. At 1½-meter intervals along each transect, a tenth square meter frame was employed to determine the canopy-coverage according to the method of Daubenmire (1959, 1968). The macroplots and transects were positioned parallel to the contours of the terrain surrounding the study sites.

Soils

Soil profiles were described at nine of the 17 study sites. Description and classification of the profiles were conducted according to the methods adopted by the National Soil Survey Committee of Canada (1965), as related by J. I. Snedon, Research Station, Canada Department of Agriculture, Vancouver, British Columbia.

Animal Distribution

Ungulate fecal droppings were counted in 10 of the 11 macroplots established in 1968 in order to assess the relative amount of grazing use of each plant community. The fecal counts were conducted within three 100-m^2 circles (5.64 meters in radius) in each macroplot. All fecal groups that were at least 50% inside the circles were recorded. Fecal groups were related to ungulate units, based on the metabolic rates of the animal species: one bighorn sheep equals 1; and one cow equals 6 ungulate units (Stoddart and Smith 1955, p. 192).

Observations were made on the numbers and distributions of bighorn sheep and cattle from April to September 1968, as well as casual observations in all years from 1961 until 1971. The nature of the observations varied, but in most cases 7 × 35-power binoculars and 20-power spotting scopes were used. Most obser-

vations were at distances greater than 440 yards after the animals had been stalked on foot.

Population Censuses and Dynamics

A series of intensive classified counts were conducted over a period of four years with the use of a helicopter. Seven counts were conducted (August and November 1968; March, August, December 1969; September 1970; August 1971).

When a helicopter was used to find bighorn to count, every gulley, ridge, and terrace on the bighorn range from Sword Creek to Bald Mountain was searched. During each count there were two persons, plus the helicopter pilot, classifying the animals observed.

The bighorn were classified into sex and age groups where possible. Rams were considered to be all male bighorn that could be definitely sexed and were usually over 2 years of age. Ewes were generally female bighorn over 2 years of age, but yearling males and females were included in this classification. Lambs were bighorn of either sex that were less than 1 year of age.

The Study Area

The Chilcotin bighorn sheep range is situated near the northern limit of grasslands in central British Columbia. Specifically, the bighorn range lies west of the Fraser River and north of the Chilcotin River (Figure 1). The northern and western boundaries are less easily defined but are considered as being the edge of the Fraser Plateau (at approximately 3,300 feet elevation) from Sword Creek south and west to Bald Mountain. The area covers approximately 70 square miles.

The Lower Chilcotin River region was glaciated during the Pleistocene period and the glacial deposits overlie olivine basalt of the Miocene and Pliocene periods (Holland 1964). The south-flowing Fraser River and the southeast-flowing Chilcotin River have eroded the glacial deposits to form several terraces and have isolated Trap Ridge from the main Fraser Plateau. The meanderings of the two rivers have also caused steep cutbanks and exposed several rock cliffs. The present elevation at the mouth of the Chilcotin River is about 1,200 feet and the elevation of Bald Mountain (the highest local point north of the Chilcotin River on the Fraser Plateau) is 5,050 feet.

The vegetation in the Lower Chilcotin River region consists mainly of grasslands and coniferous forests. The grasslands are well established on the south-facing slopes and terraces, while coniferous forests occur on northerly exposures.

A community dominated by big sagebrush (*Artemisia tridentata tridentata*) occupies the lower terraces above both rivers at elevations from 1,200 to 1,800 feet and on steep, windswept slopes up to 2,800 feet elevation. The grassland community in this region is dominated mainly by bluebunch wheatgrass (*Agropyron spicatum*) and sandberg bluegrass (*Poa sandbergii*). The *Agropyron/Poa* association is found above 1,500 feet on the lower terraces and extends to an elevation of 3,300 feet at the edge of the Fraser Plateau. A more mesic community, dominated by bluebunch wheatgrass, occurs on top of the Fraser Plateau. This community extends down to 2,800 feet elevation on Trap Ridge and about 3,000 feet elevation on the main slopes of the Fraser Plateau. At its lower limits the community exists in swales and at the periphery of coniferous forests. Small, dense groves of aspen (*Populus tremuloides*) occur on the grasslands in areas of relatively high soil moisture.

A striking contrast to the grasslands of the south-facing slopes are the Douglas fir (*Pseudotsuga menziesii*) forests on the north-facing slopes. The density of Douglas fir varies with the aspect. On northerly aspects the trees are dense, while on the easterly aspects the stands are more open. Individual mature Douglas fir trees grow in many of the deeper outwash gullies on south-facing slopes. Douglas fir is also invading the more mesic grasslands on the plateau. In the riverbreaks area this tree is becoming well established on the east-facing slopes in the *Agropyron/Poa* zone.

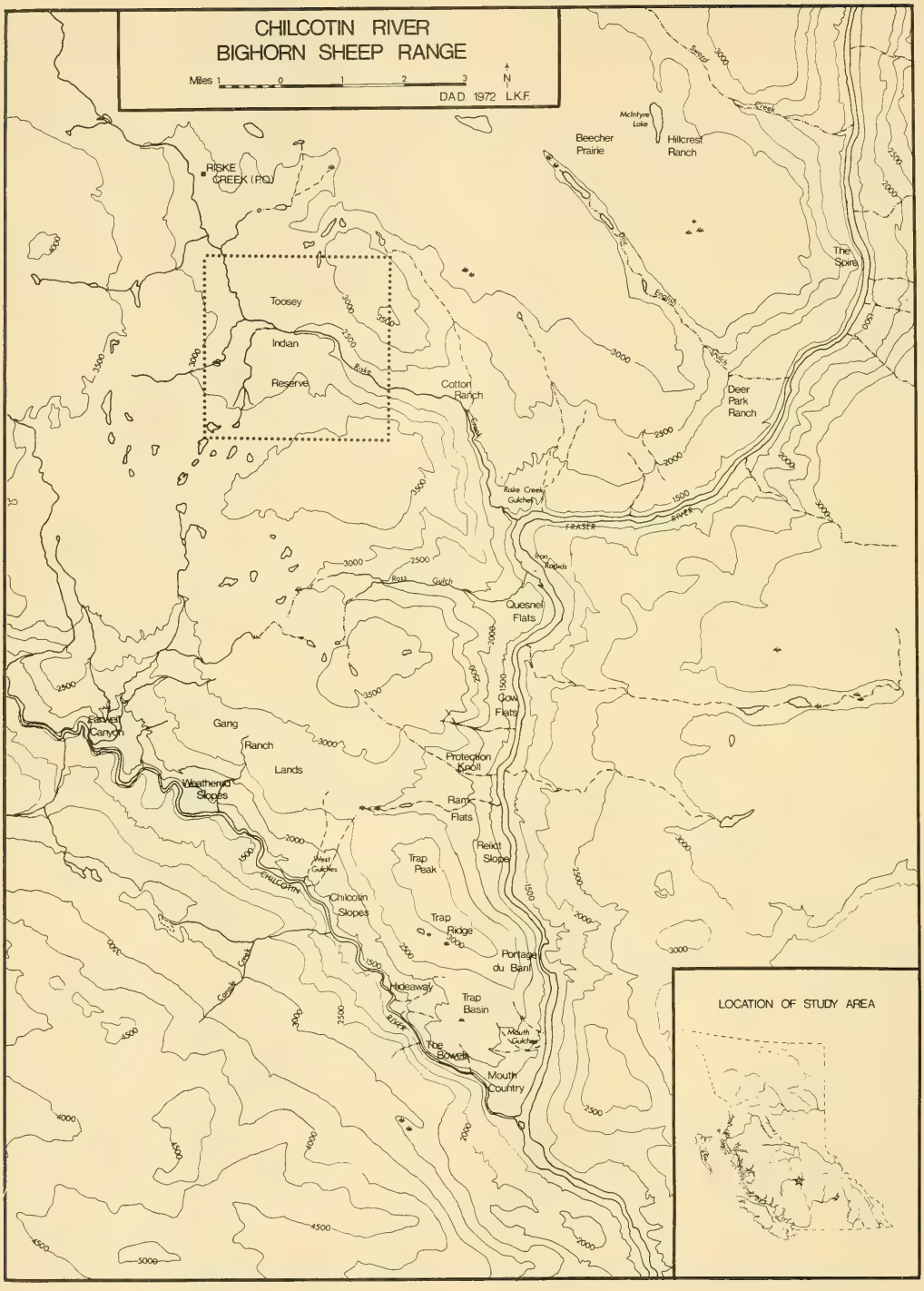

FIGURE 1. Outline map of the study area, showing geographic reference points.

Agriculture Settlement History

From the arrival of the first white explorers, the region encompassing the Chilcotin bighorn range played a supporting role in the settlement of the Cariboo–Chilcotin regions of British Columbia. Written records however, are scanty and uninformative at the best. The following is a chronological listing of readily available recorded activities in this region.

Indians had camped along the Chilcotin and Fraser Rivers for generations. A. G. Morice (1903) cites an incidence of tribal war during the seventeenth century that centered on the area of the northern grasslands. Prior to the exploration of the first white fur traders, the Indians had acquired horses. Simon Fraser, who headed the first reconnaissance of the Fraser River for the Northwest Fur Company, recorded that on June 2, 1808 he used five horses borrowed from a band of Indians just south of Riske Creek (Lamb 1960). The Chilcotin Indians probably did not acquire horses until the later part of the eighteenth century because the Indians in Northern Idaho first received horses about A.D. 1710–1730 (Haines 1938).

The Chilcotin region began its history of agricultural settlements just as the Cariboo gold rush was waning in the 1860's. Most of the present Gang Ranch lands were acquired by the Harper brothers during the period from 1863 to 1880. They first brought domestic sheep to the area, but by 1880 they had moved them to Big Bar Mountain. The range was then used exclusively for horses and cattle. In 1887 Jerome Harper sold the ranch to the Western Canadian Ranching Company. It sold out to Stoddart and Skelton in 1948 (Anonymous 1967). Between 1866 and 1870 the Cotton Ranch was settled. Deer Park Ranch was established in the period from 1871 to 1875. The following statement is taken from Weir (1964):

"Settlement followed the accessible bunchgrass ranges along the terraces of the Chilcotin River from 1873 to 1893. In addition to river lots, the early ranches acquired meadows on the uplands for hay cutting and fall grazing.

"As the Chilcotin Valley lands became stocked, settlement moved to more isolated areas on the upland, where wild meadows were abundant . . . ."

"The most spectacular advance in settlement during the period 1872 to 1885 occurred in the Chilcotin District. In 1873 'a section of land commencing from the junction of the Chilcotin and Fraser Rivers, to a point five miles below the junction of Alexis Creek and Chilcotin River' (Daily British Colonist, 1873, page 3) was declared open for pre-emption by the Land Ordinance of 1870 . . . The Riske Creek prairie received the first settlers, and by 1884 to 1885 ranches at Hanceville and across the river at Chilco were pre-empted. These include . . . the Cotton Ranch acquired by the Chilco interests."

The extensive use of the grasslands for livestock grazing became a well established practice. Morice (1903) recorded that on ". . . either side of the Chilcotin River, excellent bunchgrass affords lasting pasturage to large herds of cattle and horses." Williams (1926) stated ". . . hundreds of head of cattle, owned by the Gang Ranch . . . grow fat on the rich, natural grass. If you spy the rough ground just above the river, you are apt to spot sheep resting among the bluffs, and away above them on the plateau there may be numerous bands of cattle."

The remarks of Morice and Williams might be taken as the first indications that the ranges in this area had to support large and even excessive numbers of livestock. Photos in an annual report by W. R. Ross (1914) of the activities of the Minister of Lands indicate that the range was overgrazed at that time. One photo of the Lillooet District showed that sidehill terracing by livestock movement was evident, and there was some *Agropyron spicatum* present. Another photo showed an extensive terrace with *Agropyron spicatum* present, but *Artemisia frigida* and *Stipa comata* were more abundant. The forage did not extend past the hooves of the horses present. (Both photos between pages D84 and D85). A photo of Farwell Canyon between pages D320 and D321 showed *Artemisia tridentata* on the north bank

and *Agropyron spicatum* with much terracing on the south bank.

Specific comments and reports about the overgrazed state of the ranges followed. In October 1934, Hobson (1951) recorded that the Beecher Prairie grasses were grazed too close for the good of the range and livestock which would graze there in the next spring. In July 1935, a museum collecting expedition passed through Beecher Prairie and comments were made that the grasslands showed signs of being badly overgrazed and that the area had been depleted of practically all fodder plants (Sherman and Perry 1936).

Overgrazing had become a noticeable problem and in June 1938, the Chief Forester formed a committee that investigated range matters in the Riske Creek Area (Thomsen et al. 1938). The committee stated in their report: "In conclusion, it is obvious that present conditions in the Riske Creek area have arisen through a combination of pioneer methods, coupled with a certain laxness of administration, of which the more aggressive ranchers have been very ready to take advantage. The depletion and mismanagement of this range has reached a point where a definite grazing program, backed by strong administration, is necessary if the area is to retain its value among the grazing lands of the Province."

In the following years, the grazing problems were not corrected. Toner (1946) stated that the whole Lower Chilcotin River region was heavily overgrazed. Cattle were alleged to be keeping the grass short. In 1968 a range research program was initiated with the objective of investigating the conditions of the range and the California bighorn sheep population. Findings of that study and other continuous observations are given in detail in this report.

Plant Communities

Within the *Agropyron/Poa* zone in the Lower Chilcotin River region, four distinct communities were recognized by the dominance of certain plant species. The regression pattern of the *Agropyron/Poa* community was assumed to be: first, the *Stipa/Agropyron/Poa* community resulting from slight overgrazing; second, the *Stipa/Poa* community resulting from continual overgrazing; and third, the *Stipa/Chenopodium/Poa* community resulting from heavy overgrazing. Results to support this hypothesis are presented in the following section.

Soils

Orthic Dark Brown Chernozemic Soils were described for nine sites. This soil is derived from Aeolian material which overlies basal till. Much of the parent material has been modified by movement of the till down the slopes. The soils had an Ah horizon that varied in thickness from 4.5 to 9.5 inches. This horizon was a very dark grayish brown when moist. The boundary between this horizon and the next, the Bm horizon, was clear. The Bm horizon varied from 5 to 9 inches in thickness, and was also a dark grayish brown when moist. At two sites this horizon was strongly lithologic. The boundary between the Bm horizon and the next, the Cca horizon, was clear. The Cca horizon began from 12 to 21 inches below the surface, and was brown when moist. There was a coating of calcium carbonate on the underside of stones in this horizon. At three sites this horizon was strongly lithologic.

Agropyron/Poa Community

The *Agropyron/Poa* association was dominant on isolated terraces and steep slopes. The community was described at three sites, with elevations of 1,500, 2,800, and 3,200 feet. The slope of the sites varied from 11 to 27%, and the aspect was east and east-northeast.

The dominant plant species in this community were bluebunch wheatgrass and sandberg bluegrass (Table 1 and Figure 2). Common species included Junegrass (*Koeleria cristata*), pasture sage (*Artemisia frigida*), and pink pussytoes (*Antennaria rosea*). In addition to these species, the site at 1,500 feet contained needle-and-thread grass, big sagebrush, and bastard toad-flax (*Commandra umbellata*).

Stipa/Agropyron/Poa Community

The *Stipa/Agropyron/Poa* community formed the dominant community on areas that had animal grazing on accessible gentle slopes. This

community was described at three sites, with elevations of 1,700, 2,900, and 3,200 feet. The slope of these sites varied from 16 to 30%, and the aspects were east, south, and south-west.

Dominant plant species in this community were needle-and-thread grass, bluebunch wheatgrass, and sandberg bluegrass (Table 1). Associated plant species were Junegrass, pasture sage, dwarf pussytoes (*Antennaria dimorpha*),

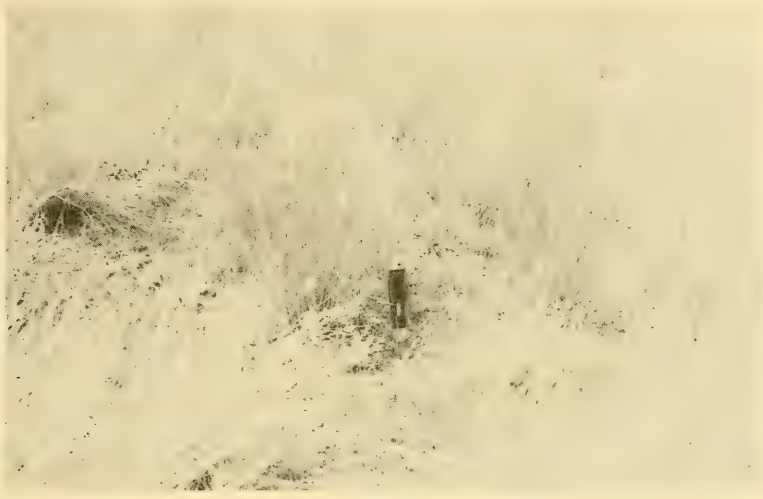

FIGURE 2. *Agropyron/Poa* community on Protection Knoll.

TABLE 1. — Percent canopy cover of major plant species of 10 sites in the *Agropyron/Poa* zone studied in 1968

Plant species	*Agropyron Poa*			*Stipa/Agropyron/Poa*			*Stipa/Poa*			*Stipa/ Chenopodium/ Poa*
	RS[a]	TP	PK	RS	TP	PK	RS	TP	PK	TB
Grasses										
Agropyron spicatum	40	27	33	7	6	10	1	4	6	t
Koeleria cristata	2	8	14		1	2		t		
Poa sandbergii	7	13	12	13	1	2	6		2	5
Stipa comata	21		t	30	14	25	60	24	30	26
Shrubs										
Artemisia frigida	13	8	7	4	8	2	4	6	2	9
Artemisia tridentata	6						1			
Forbs										
Antennaria dimorpha			1	1	t	3	1	t	t	2
Antennaria rosea	1	4	4	3	t	1	t	t	t	
Chenopodium album	1			2	t	3	3	1		7
Comandra umbellata	7		3			2	5	t		
Lepidium densiflorum					t	t	t			2
Opuntia fragilis				t	t	t	1	t	t	1

[a]The initials refer to: Relict Slope, Trap Peak, Protection Knoll and Trap Basin; t = trace (<.5%).

pink pussytoes, lamb's quarters (*Chenopodium album*), peppergrass (*Lepidium densiflorum*), and prickly pear cactus (*Opuntia fragilis*).

Stipa/Poa Community

The *Stipa/Poa* community formed the dominant community over the majority of the grasslands in the Lower Chilcotin River region. This community was found on gently rolling hills and the broad extensive terraces common to the region and was described at three sites, with elevations of 1,500 and 3,100 feet. The slope of the sites varied from 11 to 27%, and their aspects were east, south-southeast, and south.

FIGURE 3. *Stipa/Poa* community on Protection Knoll.

TABLE 2. — Percent canopy cover of major plant species of six sites in the *Stipa/Poa* community sampled in 1971

Plant species	Trap Ridge		Trap Basin	Dry Farm		
	1	2	3	4	5	6
Grasses						
Agropyron spicatum	3	4	t	t	1	1
Koeleria cristata	9	4	5	4	2	4
Poa sandbergii			2	t		t
Stipa comata	27	36	62	43	29	29
Shrubs						
Artemisia frigida	12	15	2	12	14	12
Artemisia tridentata		t[a]				
Eriogonum heracleoides						2
Forbs						
Antennaria spp.	1	t		1	2	2
Arabis holboellii	1	t	t	t	t	1
Commandra umbellata	2	3		1	1	1
Lepidium densiflorum						1
Opuntia fragilis				1	t	t

[a]t = trace or less than .5%.

Dominant plant species in this community were needle-and-thread grass and sandberg bluegrass (Table 1 and Figure 3). Associated plant species were bluebunch wheatgrass, pasture sage, dwarf pussytoes, pink pussytoes, lamb's quarters, and prickly pear cactus. The site at 1,500 feet also contained big sagebrush and bastard toad-flax.

In 1971, six macroplots were established on the area (these sites were referred to as being in the *Stipa/Poa* community) and the data were comparable to those collected in 1968 (Tables 1 and 2). The most notable difference was the lack of lamb's quarters in the 1971 sites. Junegrass and pasture sage, however, were much increased in the 1971 sites. Sandberg bluegrass was hardly recorded but it is believed it was missed owing to the sampling date, at which time it had undoubtedly gone into summer dormancy.

The change in the amount of lamb's quarters, June grass, and pasture sage was probably due to the change in livestock management on the area. Site 3 was located very close to the *Stipa/Chenopodium/Poa* site and sites 1 and 2 were very close to the Trap Peak *Stipa/Poa* site. It is unfortunate that a direct comparison was not made from the 1968 sites, but we feel that the comparisons made are valid.

Stipa/Chenopodium/Poa Community

The *Stipa/Chenopodium/Poa* community formed the dominant vegetation on the most accessible terraces and around salting stations and watering places. One site was described in this community, at 2,150 feet on a terrace with a 5% slope and south-west aspect.

Dominant plant species in this community were needle-and-thread grass, lamb's quarters, and sandberg bluegrass (Table 1 and Figure 4). Associated plant species were pasture sage, dwarf pussytoes, peppergrass, and prickly pear cactus.

Artemisia/Agropyron Community

Big sagebrush (*Artemisia tridentata*) grows in two habitats in the region. The first habitat is on the lowest terraces (below 1,800 feet elevation) above the Fraser and Chilcotin Rivers. The second habitat is on steep, rocky slopes, with southern exposures, up to 2,800 feet elevation. The communities are essentially the same, except that there is more natural disturbance by erosion in the latter community.

Only one site was described in the *Artemisia/Agropyron* community and that was on a low terrace at 1,600 feet. This community had received heavy grazing pressure and was not readily found in the climax condition. Big sage-

FIGURE 4. *Stipa/Chenopodium/Poa* community on Trap Basin.

TABLE 3. — Percent canopy cover of major plant species of one site in the *Artemisia/Agropyron* community studied in 1968

Plant species	Percent canopy cover
Grasses	
Agropyron spicatum	31
Poa sandbergii	3
Stipa comata	t[a]
Shrubs	
Artemisia frigida	1
Artemisia tridentata	29
Forbs	
Arabis holboellii	1
Lappula echinata	1
Opuntia fragilis	3

[a]t = trace or less than .5%.

brush and bluebunch wheatgrass were the dominant species (Table 3). Sub-dominant species were sandberg bluegrass, pasture sage, and prickly pear cactus.

Climate

Climatological data were lacking for the Lower Chilcotin River region. The closest active weather stations were situated at Big Creek and Williams Lake Airport which are 25 and 35 miles distant, respectively. Both stations are situated on the Fraser Plateau, the Big Creek Station being southwest of the bighorn range at 3,720 feet elevation and the Williams Lake Airport station being northeast of the range at 3,088 feet elevation. Data has been collected at the Big Creek Station since 1931, while the Williams Lake Airport weather station has only been in operation since the mid 1950's. One other station, the Dog Creek Airport station has been abandoned but it had operated from 1948 to 1960. That station was located at 3,370 feet elevation at the edge of the Fraser Plateau in the Fraser Valley and was only 11 miles south of the bighorn range.

The Big Creek station rather than the Williams Lake Airport was used to plot the weather patterns from June 1968 to May 1969. The Big Creek station had a mean that encompassed more years and the Big Creek Station data fit more closely to the Dog Creek Airport data (which was closer to the bighorn range). Analysis of the Big Creek data reveals several anomalies in the year June 1968 to May 1969 compared to the 30 year normal (Figure 5). June 1968 was drier than normal, July was wetter, August was cooler, October was drier, but December was much colder and wetter, and January 1969 was much colder, March was drier, April was wetter, and May 1969 was drier.

During the period from 1961 to 1970, the mean cold temperatures of 5 and –10 degrees Fahrenheit in December 1968 and January 1969, respectively, were rivalled only by December 1964 and January 1965 when the mean monthly temperatures were 2 and 11 degrees, respectively (British Columbia Department of Agriculture 1961 to 1970). The total precipitation for December 1968 and January 1969 of 2.72 inches was not great and well below the 4.05 and 4.18 inches recorded in December 1961, January 1962, or December 1963, January 1964, respectively. However, the November–December 1968 accumulated total of 3.14 inches of precipitation and the December 1968 total of 2.20 inches of precipitation were the largest recorded in the 1960's. These extremes were similar to the data recorded at the Williams Lake Airport in 1968 and 1969 with heavy November–December accumulated precipitation totals of 4.49 inches (2.88 in December 1968 alone), while the December–January totals were about normal for the 1960's.

The Bighorn Population

The Chilcotin River bighorn population does not make annual migrations between summer and winter ranges but occupies the same general area at all seasons. On this range the bighorn are distributed as two separate herds of ewes and lambs with one main ram herd and two small bands. A small herd of ewes and lambs inhabit the area from Sword Creek south to Riske Creek. These animals are commonly referred to as the Deer Park herd as they live

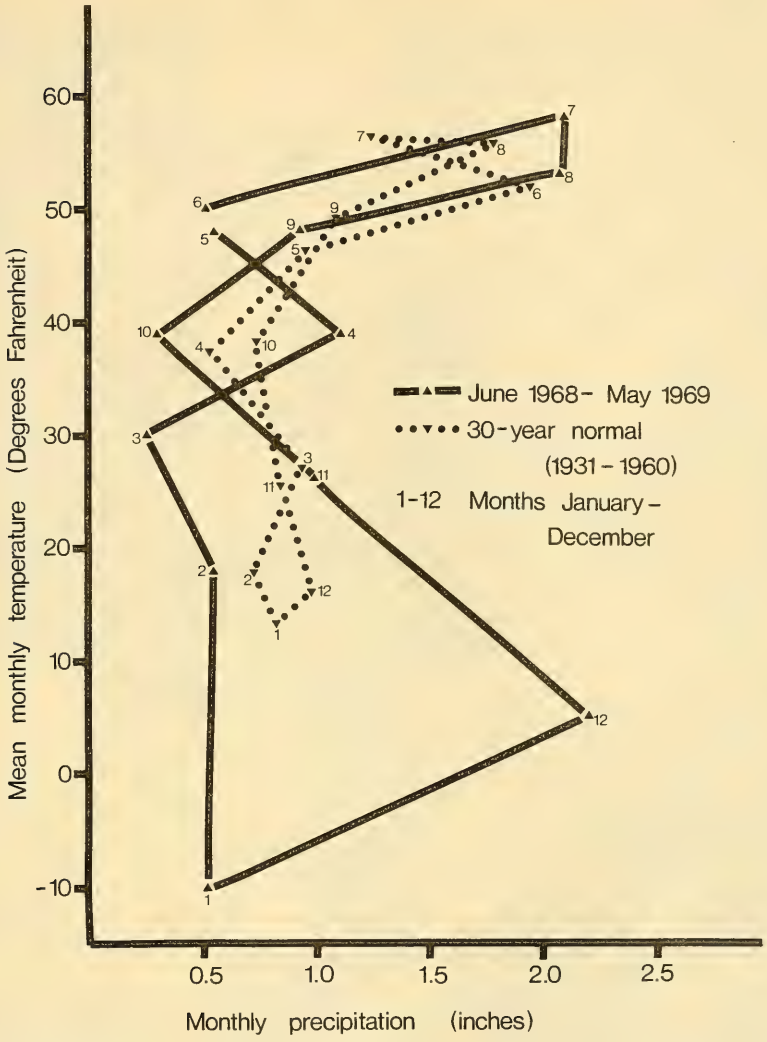

FIGURE 5. Thermal-hydro graph of 30-year normal and June 1968 to May 1969 from Big Creek weather station data.

on and around Deer Park Ranch lands. The area from Doc English Gulch south across Riske Creek and Ross Gulch to Relict Slope* is the main area occupied by the rams except during the rutting season. The second ewe herd extends south and west from Relict Slope. This herd has been designated as the Junction herd, because the bighorn inhabit the area close to the junction of the Chilcotin and Fraser Rivers (Figure 6).

The bighorn of the Junction herd appear to be separated into three smaller bands that overlap in their distribution. A small group of ewes range from Relict Slope to the Mouth Gulches and Trap Basin; a large group of ewes range from the Mouth Country across Trap Basin to

*All major geographical features are referred to by local names and names proposed by the writers for convenience. For reference to these names see Figure 1.

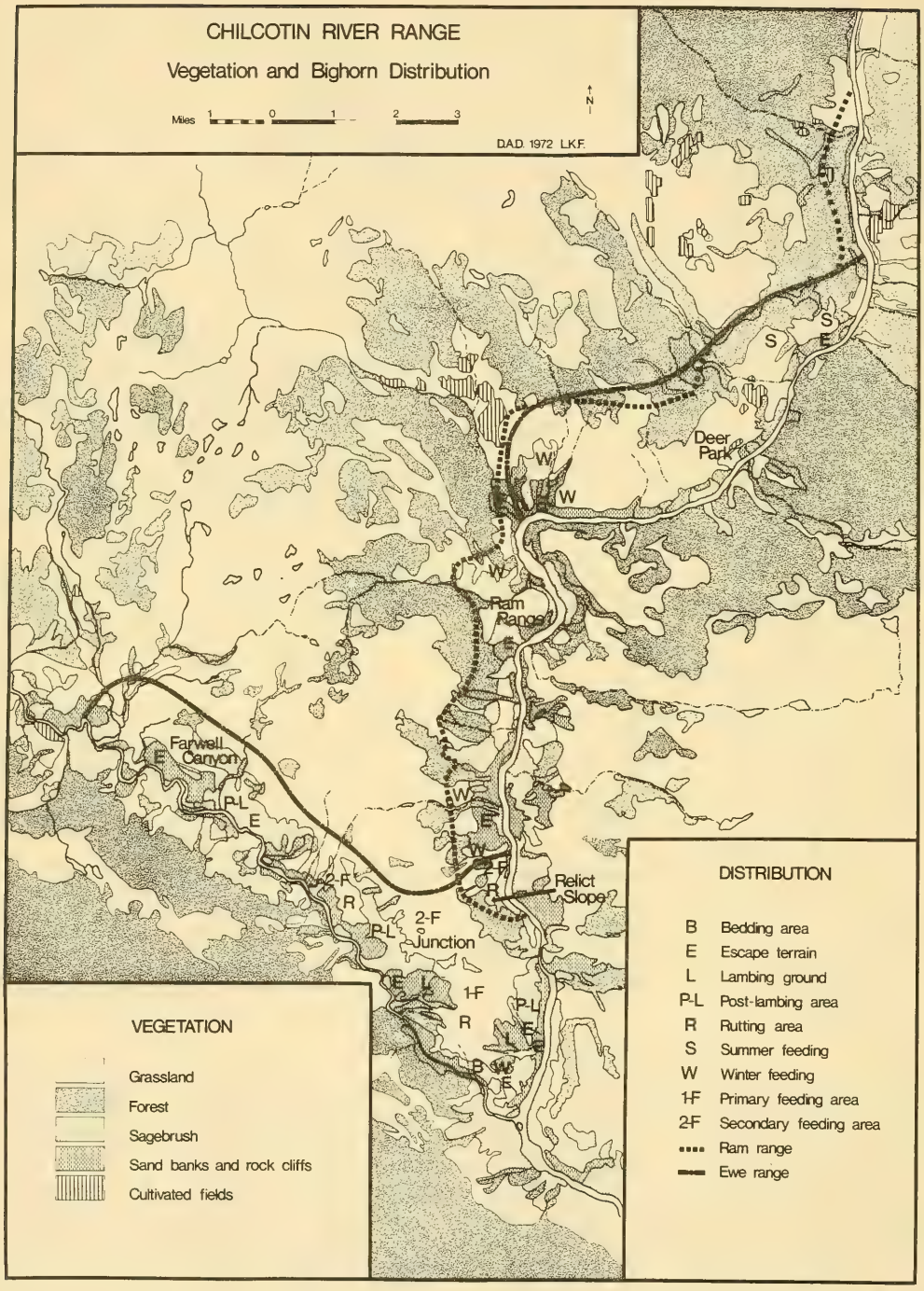

FIGURE 6. Vegetation and bighorn distribution map of the study area.

the Chilcotin Slopes, while a third group occupies the area from Farwell Canyon southeast to the Chilcotin Slopes.

Deer Park Herd

The ewes and lambs in the Deer Park area spend most of the snow-free months along the rimrock and river "breaks" north of Doc English Gulch. They have often been observed on the talus slopes and grassland below the Spire. Most of the rutting activity occurs in this area.

During the winter months the small herd of ewes and lambs move southward into the windswept gulches of Riske Creek. They remain here until the snow "disappears" from the Doc English Gulch area.

In 1954 Lawson Sugden counted 46 ewes and 23 lambs on the Deer Park Ranch. During the next four years, 110 bighorn were transplanted from this area (44 ♂♂, 34 ♀♀, 32 lambs). However, in August 1968 only 19 ewes and five lambs were counted (Table 4). During the winter of 1968–1969 there was a population decline and in March 1969 only 10 ewes and three lambs were counted. On August 12, 1971 only 12 ewes and seven lambs were counted. While the latest data indicates that this herd is returning to the 1968 level, the herd certainly had fewer animals than in 1954.

The live trapping and consequent removal of ewes and lambs from Deer Park were excessive and undoubtedly resulted in the near extinction of this herd. The trapping was thought to have created a vacancy in the supporting habitat and thus it was hoped that ewes and lambs from the southern Junction herd would be enticed to immigrate to the Deer Park area (Sugden 1961 and personal communication). Hindsight now shows us that there is no ready exchange of ewes and lambs between the two herds and therefore it was unwise to have accounted for such an activity in the trapping plans.

Junction Herd

The Junction herd relies on the eroded, clay-silt slopes for escape terrain and for lambing grounds (Figure 7). After the lambs are born in May and early June, the ewes move onto the steep, rocky, sagebrush-covered slopes that are adjacent to the lambing grounds. They use these slopes as feeding grounds and as a nursery, but they still use the extensive clay-silt banks as escape terrain. As the lambs get older, the ewes take them to the top of Trap Ridge to feed. Only after the first-born lambs are about 6 weeks old do the ewes venture onto Trap Basin to feed. This rolling wide terrace offers no readily available escape terrain except near its perimeter. After this time, the ewes and lambs feed mainly on this terrace and feed on other terraces secondarily. The lower sagebrush terraces and rocky, sagebrush slopes are utilized as bedding grounds. The ewes and

TABLE 4. — Helicopter classified counts of the Chilcotin River bighorn sheep population

Date	Rams	Deer Park		Junction		Total
		Ewes	Lambs	Ewes	Lambs	
March 3, 1961	—	—	—	—	—	401
August 2, 1968	74	19	5	182	76	358
November 22, 1968	80	19	4	143	33	283
March 13, 1969	49	10	3	130	32	231
August 23, 1969	23*	2*	4*	112	53	205
December 1, 1969	58	14	5	121	51	243
September 28, 1970	56	6*	6	125	31	229
August 12, 1971	57	12	7	138	52	266

*Low count possibly influenced by observation difficulties.

FIGURE 7. Junction herd escape terrain and lambing grounds. The slopes and cliffs on the left are used as feeding areas and escape terrain, while clay banks in the center of the photo are used as lambing grounds and the terrace immediately above is used as the main feeding and rutting area.

lambs move upslope daily to feed on Trap Basin.

The greatest concentration of rutting activity takes place on Trap Basin. These ewes, however, also move onto Relict Slope and the Chilcotin Terraces for breeding.

During 1968 the first lambs were noted on May 3 when eight lambs were seen. They were quite agile and followed the females from the silt banks down to the sagebrush areas above the Chilcotin River. Newborn lambs were noted from that date until June 13 when a very small lamb was observed as one of a band of three ewes and three lambs.

The number of lambs observed increased daily from May 3 until May 8 when 15 lambs were observed with 29 ewes. Days of observations were few after the latter date, but on June 6, 109 ewes and 68 lambs were classified. This last count identified the highest number of lambs in the Junction herd.

Considering the increase of number of lambs from May 3 to May 8 to June 6 it was postulated that most lambs were born before May 15. The peak lambing period was considered to be May 6 to May 15. The length of the lambing period was 6 weeks occurring from May 1 to June 15. The earliest that lambs have been observed on this range was April 21 (Sugden 1961) and April 22, 1962.

A small band of ewes and lambs occurs along the Fraser River from Relict Slope to the Mouth Gulches and Trap Basin. These appear to be only a splinter group from the other ewes and lambs in this area. Their lambing grounds are the Mouth Gulches and the post-lambing area is the rocky sagebrush — bunchgrass slopes of Portage du Baril. These sheep frequently feed on Relict Slope, Trap Basin, and the small grassy terraces of the Mouth Country. Some rutting activity occurs in the Relict Slope area (Figure 8).

A band of ewes and lambs frequents the gulches and terraces along the Chilcotin River from Farwell Canyon downstream to the Hideaway. Bighorn that frequent the Chilcotin Slopes can not be identified as being either Farwell Canyon or Junction bighorn. It can only be postulated that most of the ewes and lambs that frequent the Chilcotin Terraces are

FIGURE 8. Relict Slope area. The ridges in the foreground are utilized as bedding areas for rams, the gentle slopes are used by ewes and rams as feeding grounds and as a rutting area.

of the Farwell Canyon band. Also, these same terraces could be used by the Farwell Canyon band as the rutting area.

Classified counts conducted in August 1968 located 182 ewes and yearlings and 76 lambs. Both figures represent the highest number of animals counted during the series of surveys (Table 4). By November 1968 only 143 ewes and yearlings and 33 lambs could be located. The March 1969 count revealed 13 fewer ewes and yearlings. Censuses conducted in August and December 1969 and September 1970 located 112, 121, and 125 ewes and yearlings, respectively. These consistently low counts indicate that a die-off had occurred in the winter of 1968–1969. The number of lambs counted in the same period was lower than in August 1968 but the proportion of lambs per 100 ewes remained about the same, between 37 and 46 (Table 5).

Ground counts conducted on a limited portion of the range on animals of the Junction and Relict Slope bands during the lambing periods indicated high ratios of lambs to 100 ewes. In May 1964, 218 animals were classified, indicating a ratio of 77 lambs per 100 ewes. In June 1968, 179 animals were classified, indicating a ratio of 62 lambs per 100 ewes. The sample sizes for these two early season counts were very large, but many ewes without lambs were obviously missed as a late July 1968 count of 186 ewes and lambs indicated 50 lambs per 100 ewes, while a more extensive search with a helicopter in the same

TABLE 5. — Age and sex ratios of classified counts of the Chilcotin River bighorn population

Date	Method of access	Rams	Ewes	Lambs	Number classified
May 22, 1964*	Walking	—	100	77	218
June 7, 1968	Walking	—	100	62	179
July 21, 1968	Walking	—	100	50	186
August 2, 1968	Helicopter	37	100	41	358
November 22, 1968	Helicopter	48	100	22	283
March 13, 1969	Helicopter	34	100	25	231
August 23, 1969	Helicopter	18**	100	46	205
December 1, 1969	Helicopter	45	100	44	243
September 28, 1970	Helicopter	43	100	37	229
August 12, 1971	Helicopter	38	100	39	266

*J. Lesowski (personal communication).
**Low count due to observation difficulties.

area 13 days later revealed a ratio of 41 lambs per 100 ewes.

Notwithstanding the possibility of a biased sample the ground counts during the lambing period does give an insight into the population recruitment potential of this bighorn herd. The mid-winter and late winter counts also give an indication of the survival of lambs. Unfortunately yearlings could not be consistently identified so there is no survivalship indications for yearlings, and the number of yearlings classified as adult ewes was unknown. Therefore the ratios of lambs to 100 adult ewes are lower than actually exist.

Ram Herd

During the period from winter to early fall, the rams most commonly frequent the area from Relict Slope to Doc English Gulch. A few rams are frequently observed north of the Deer Park Ranch along the river "breaks" below the Chilcotin Highway and a few rams are observed in Farwell Canyon. The rams use a wide diversity of areas and are seldom observed consistently in the same area. Band size fluctuates daily as individuals and small bands wander over their range. For short periods in the summer months, some rams can even be observed on the ewe ranges.

In September, before the onset of the rut, the rams seem to wander more and show up on the ewe ranges more frequently. In early October, the start of the rut, the rams remain on the ewe ranges. During the rut the rams do a great deal of wandering, undoubtedly seeking ewes in oestrus. At this time rams are seen most commonly on the ewe ranges although occasionally they return to the ram range.

The rams are slow to return to the ram range after the rutting period and some remain on the ewe ranges well into winter. Individuals and small bands wander a great deal until December or January, while most of the rams have returned to the Fraser River ram range to winter.

Classified counts conducted on August 1968 and November 1968 were able to locate 74 and 80 rams respectively (Table 4). After the severe winter of 1968–1969 a classified count conducted in March 1969 was able to locate only 49 rams, but a count conducted in December 1969 located 58 rams. Summer counts in two subsequent years classified about the same number of rams, 56 and 57. The data collected reveals a definite decline between December 1968 and March 1969, with only a slight recruitment the following winter and the next two years. The difference between the counts of March 1969 and December 1969, might be due to the observation limitations of the classified counts, or it might represent the yearling ram recruitment into the ram population.

Mortalities

Skeletons of bighorn have been located throughout the bighorn range. Ram skeletons have a wider distribution than those of the ewes or lambs. More specific information is required about the time of year and reasons for death, but there are two reasons for the difference in distribution of dead bighorn of both sexes.

1. Females and lambs have a much smaller range than males when the wandering of males during the rut is considered.

2. The two periods most stressful to bighorn are the breeding and wintering period (Geist 1971). The number of ram skeletons found on the ewe ranges bears this out.

Causes for mortality are not easy to determine when one only examines skeletons. However, two rams were found dead on the same spot on the ewe range and could have died fighting; one other ram had a horn broken at the lamb tip and could also have died fighting. One mature ram possibly had a broken foot. One ewe had "lump jaw," the lower jaw being swollen and the lower molars very long, indicating lack of wear; this diseased jaw might have been the cause of the ewe's death.

One lamb had been devoured by a black bear. There was no evidence to show if the bear had actually killed the lamb or was only scavenging an already dead animal. On October 24, 1971 a coyote was seen sneaking up on a herd of ewes feeding in the center of Trap Basin. When close enough the coyote began chasing one ewe that ran to the escape terrain in the Hideaway. At first the ewe outdistanced the coyote, but the chase continued for nearly one-half mile and before both sheep and coyote ran down into the Hideaway the coyote was only 20 feet behind. It is not known if the ewe was killed, but this incident indicates that predation on bighorn by coyotes must occur. Similarly, a cougar was observed as it stalked within 75 yards of three mature rams; it then began to chase the rams. It was shot before its hunt was completed and therefore there was no opportunity to judge its hunting success. Finally, one ewe was definitely shot, as the bullet entered between her eyes and broke off her lower jaw. Other sheep are shot on occasion, some are deliberately poached, while others are shot mistakenly (probably for mule deer). The exact number of animals killed in this manner is unknown, and would probably depend more on the accessibility of mule deer in this area during the hunting season than on any other factor.

Bighorn and Cattle Use of Grassland Communities

During the grazing period of 1967–1968 yearling steers in the Junction herd range grazed most plant communities and traversed steep rocky slopes or steep timbered slopes to gain access to grassy terraces or slopes. The steers showed no area preferences for grazing, but did congregate around the ponds and salt blocks (which were frequently located near the ponds). When snow was on the ground the steers foraged on the windswept terraces and slopes close to the river until larger areas were blown free of snow (J. Dodd, personal communication).

Observations on brood cows along the ram range on the narrow Fraser River terraces revealed that they moved very little from area to area because of the difficulties of access. Cows calved in the community dominated by big sagebrush. Shortly after the calving, the cows and calves were rounded up and moved to summer pasture.

Bighorn have been observed in all major habitat types within a short distance of the edge of each terrace which afforded escape terrain. The ewes, lambs, and yearlings were even observed on the largest grassland terraces which are surrounded by escape terrain. Rams were observed on narrow grassland terraces along the Fraser River. These terraces are below the Douglas fir forests, and are bounded by steep silt banks. Evidence of trails and bedding sites indicated that the rams also spent considerable time in the Douglas fir forests.

Fecal group counts conducted in 1968 in 10 macroplots in the *Agropyron/Poa* zone indicated that the grazing intensity of cattle and bighorn varied in each area. The highest ungulate unit values per square meter for bighorn

were found in the *Agropyron/Poa* and *Stipa/Agropyron/Poa* communities (Table 6). The ungulate unit values per square meter for cattle were highest in the *Stipa/Chenopodium/Poa* community and successively lower in the *Stipa/Poa, Stipa/Agropyron/Poa,* and *Agropyron/Poa* communities. This trend was consistent except for one site in the *Agropyron/Poa* community where recent invasion by cattle had occurred.

TABLE 6. — The use of various communities in the *Agropyron/Poa* association by cattle and bighorn (fecal groups per square meter weighed by the metabolic rate of the ungulate)

Plant community	Site	Ungulate units per square meter		
		Cattle	Bighorn	Total
Agropyron/Poa	RS[a]	1.00[b]	0.06	1.06
	TP	0.32	0.08	0.40
	PK	0.32	0.14	0.46
Stipa/Agropyron/Poa	RS	0.52	0.27	0.79
	TP	0.82	0.09	0.91
	PK	0.60	0.07	0.67
Stipa/Poa	RS	0.94	0.07	1.11
	TP	1.02	0.04	1.06
	PK	0.54	0.08	0.61
Stipa/Chenopodium/Poa	TB	2.08	0.06	2.14

[a]The initials refer to Relict Slope, Trap Peak, Protection Knoll, and Trap Basin.
[b]Result of recent increased use by cattle.

Discussion

Bighorns and the Plant Communities

The plant communities in the *Agropyron/Poa* zone of the region appeared to be changing as a result of grazing, and four plant communities were recognized by the varied dominance of three plant species: bluebunch wheatgrass, needle-and-thread grass, and lamb's quarters. This zone has a relatively uniform soil type indicating that one plant community should become climax, with the ultimate elimination of all other successional stages.

Although certain habitat factors of this region were relatively constant the grazing use of each plant community was not uniform. Access was the main cause for this discrepancy in use. Gullies, ridges, and fences blocked access to cattle on several of the slopes and terraces. While this limitation was not of serious consideration to the bighorn, they were limited in their distribution by lack of escape terrain and habitual avoidance of certain areas. As a consequence of these use differences the *Agropyron/Poa* zone does not have a uniform plant community.

The isolated terraces and slopes that received mainly bighorn use retained the climax *Agropyron/Poa* community. The bluebunch wheatgrass was dense, while needle-and-thread grass was non-existent or sparse. In this community Junegrass had its greatest cover and weedy annuals were sparse.

As the grazing use of this plant community increased, needle-and-thread grass grew more abundantly to become a dominant species. Bluebunch wheatgrass began to diminish as did Junegrass. Two weedy perennials, prickly pear cactus and dwarf pussytoes invaded this community and weedy annuals began to be more abundant.

The *Stipa/Poa* community stage of plant succession was found to be the most common in the region. Past and present grazing use has had its greatest effect in this type. Needle-and-thread grass was most dense in this community. Bluebunch wheatgrass had decreased greatly in density; pink pussytoes had begun to decrease in density and Junegrass was virtually eliminated. The weedy annuals and perennials of the *Stipa/Agropyron/Poa* community had become more abundant.

Certain areas of the *Agropyron/Poa* zone had received an abnormally heavy concentration of cattle and bighorn. In such cases the overgrazed seral community of *Stipa/Poa* regressed even further to the *Stipa/Chenopodium/Poa* community. An annual weed, lamb's quarters, became a dominant species. Needle-and-thread grass, while still dominant, was less abundant in the community than in the pre-

vious stage. Another weed, peppergrass, invaded at this successional stage.

Once the livestock pressure was reduced, as it was in the 1969–1970, 1970–1971, and 1971–1972 winter grazing periods, regression of the *Agropyron/Poa* zone was halted. Lamb's quarter ceased to become a dominant plant and it even failed to become common in most previously abused sites. Junegrass and pasture sage began to increase in density.

It is apparent that the rate of succession in the *Agropyron/Poa* zone is related to the extent and amount of livestock grazing. While changes were observed in only four years of a changed grazing regime it is impossible to know how long it would take for the *Stipa/Poa* community to return to the climax or *Agropyron/Poa* community. McLean and Tisdale (1972) studying several grassland exclosures in southern British Columbia determined that under total ungulate prohibition it took from 23 to 40 years for a site to progress from being very overgrazed to near climax. They also stated that it took much longer for the sites to progress from poor to fair condition than from fair to good condition.

There was one other interesting but perhaps only coincidental observation regarding the distribution of the Junction herd of ewes and lambs. During the period from late April to late June (the lambing period), the bighorns avoided Trap Basin, an area that afforded them the greatest feeding surface throughout the remainder of the year, except when there was deep snow. If Trap Basin was not overgrazed and supported the *Agropyron/Poa* climax community as it undoubtedly once did, then such a temporary grazing absence would occur at a time that is most beneficial to bluebunch wheatgrass, the growing leaf establishment stage. This late spring period is the time when bluebunch wheatgrass is most vulnerable to grazing, because it has mobilized its stored carbohydrates which move to the growing tips of leaves. If the growing tips are removed before they have started to produce their own carbohydrates then the plants lose some of their potential to produce more carbohydrates. Thus the plants will not have as much carbohydrates the next growing period and will be even more susceptible to overgrazing. Bluebunch wheatgrass grows only during the warm spring rains and is dormant during the summer drought. Some growing may occur with fall rains but it is the spring growth which contributes most to the storing of carbohydrates. (McIlvanie 1942; Harper 1969; Laude 1964).

This trait of the Junction bighorn to avoid Trap Basin during the spring growing season may be a form of migration. Although the distance is small and not measurable, the effect is the same: that a critical winter feeding area is vacated for a part of the year. The ewes and lambs resume feeding on Trap Basin when the lambs are large and do not need to live right on the escape terrain; this coincides with the maturation of the forage. If the distances involved were about five miles this would be called a migration but since the distances are much less this movement can only be categorized as a pseudo-migration.

Geist (1971) has stated that home ranges for male and female mountain sheep are varied and suit different purposes for each sex. For the males he outlined a potential of four home ranges during the winter and two during the summer; for the females he outlined only four home ranges. The winter home ranges for the males are (1) the fall or pre-rut home range; (2) the rutting ground or rut home range; (3) the mid-winter home range; and (4) the late winter/spring home range. The two summer home ranges for the males are (1) the salt-lick home range; and (2) the summer home range. The four home ranges of the females are (1) the winter home range; (2) the late winter/spring home range; (3) the summer home range; and (4) the lambing-ground home range (tentative).

The Chilcotin River bighorn population do not have such home ranges. The males have two home ranges: (1) the summer/winter home range; and (2) the rutting-ground home range. Relict Slope might be considered as a pre-rut home range as they do occur there quite commonly in the fall; they do, however, make use of that area at all seasons, even the rutting period. No bighorns have ever been

seen using natural salt licks and therefore there is no such home range for this population.

The females appear to have three home ranges which serve several purposes. They have a winter home range which is the same area as the lambing home range. They also have a spring/summer/fall home range.

The compressed nature of their range, their non-migratory habits, and the proximity of the males to the females in the summer certainly precludes the possibility that the Chilcotin River bighorn have home ranges as described by Geist (1971). Such knowledge is very important for management decisions of this resource.

Bighorn Population Decline

Die-offs of bighorn populations have been described for Rocky Mountain bighorn (*O. c. canadensis*) by Buechner (1960) and Stelfox (1971). Buechner (1960) summed up most of what was known about die-offs in bighorn populations when he said that disease, principally lungworm, causes a sudden and severe mortality which is triggered by poor nutrition from temporary deterioration of forage on winter ranges. He also stated, however, that the violent population fluctuations caused by lungworm are characteristic of bighorn populations found only in the Rocky Mountains.

Stelfox (1971) prepared a comprehensive treatise on the history of die-offs of the Rocky Mountain bighorn sheep in the Canadian Rockies. He noted that there have been three periods of die-offs in recorded history: 1860–1915, 1937–1950, and 1964–1970. He attributed the first die-off primarily to indiscriminate hunting with firearms by Indians, and the influx of traders, explorers, settlers, and miners; and secondarily to interspecific forage competition by several thousand horses and cattle, fires, railway and mining construction, and three excessively severe winters. The second and third die-offs he attributed to pneumonia-lungworm disease and severe winter weather. Underlying those factors was the deterioration of critical winter ranges by excessive elk, mule deer, and bighorn populations.

Studying California bighorn sheep west of the Fraser River, Sugden (1961) stated that a population decline had occurred in the period 1910–1920, but he felt there had not been a dramatic die-off, only a moderate change. He ruled out that possibility of such a change being from hunting, predation, or disease, and felt that overgrazing of the ranges by horses and cattle could have been important. It was his opinion that the bighorn were undergoing only natural fluctuations and that hunting and predation merely replaced disease or starvation, which would ultimately have reduced the herds as the larger herds could not have been maintained on the existing winter ranges.

Sugden (1961) speculated that the bighorn numbers on this range fluctuated over the years with a major low in 1915. His estimate in 1954 was 250 animals, which was reported to be the highest since 1915. In March 1961, however, 401 bighorn were observed during the most intensive survey up to that time.

The 1961 count appears to indicate an increase of 150 animals in just seven years, but 115 animals were transplanted from the Deer Park herd in four years, and the Deer Park herd actually declined from about 75 ewes and lambs to about 25 ewes and lambs. Thus most of this apparent increase would have occurred in the Junction herd. There was a great discrepancy in the observation ability of the 1954 and 1961 surveys. Surveys conducted in 1968 in the same manner as in 1954, that is, ground counts only, revealed a maximum of 250 animals. Therefore, it is suggested Sugden's counts in the mid-fifties were low, how low can not be calculated now. Certainly, the 1961 data and the information that we have concerning the Deer Park herd indicate that he underestimated by about 150 to 250 animals.

Other historical data are suspect: one game warden that was policing the area from 1935–1953 is thought to have altered the data collected. This was done so that later data would show an increased population and his efforts would be considered responsible for the improvement (J. P. Gibault, personal communication). Toner (1946) recorded that he was told there were 100 ewes and lambs on the Lower Chilcotin River area in 1944; he was also told that only 10 years previously there

were only *three* animals present. Careful protection of the herd was said to be responsible for such a remarkable recovery. Thus the magnitude of any population fluctuation up to 1961 is lost owing to deliberate lies and the lack of proper observation facilities.

In November 1962, J. Lesowski, (personal communication) estimated 300 bighorn on Trap Basin during the rut. In November 1964 he counted a comparable number of bighorn on the same area. These counts are consistent with the 1961 count for the same area.

In August 1968, during a helicopter survey of the entire bighorn range, 358 bighorn were classified. However, surveys subsequent to August 1968 indicated a decline in bighorn numbers (Table 4). During the winter of 1968–1969 the number of rams and ewes declined. Surveys from the following summer and winter indicated that the population decline had leveled off; an early fall survey of 1970 confirmed this observation. The August 1971 survey indicated that the numbers of ewes had increased slightly, suggesting that the survival of lambs in the 1970–1971 winter was better than any winter since 1968. However the number of rams had not shown any increase in the same period.

Indications are that from August 2, 1968 to March 13, 1969 the bighorn population underwent a serious decline. The number of lambs declined between August and November; the number of rams declined between November and March, and the number of ewes declined steadily over the entire period.

Population recruitment has since been very low. The last count in each year of 1968–1969, 1969–1970, 1970–1971 indicated that recruitment of female lambs (50% of the lambs classified) into the ewe herds was 12, 22, and 12% respectively.

Considering that the Chilcotin River bighorn population declined in 1968–1969 and that the population was subsequently maintained at a low level, it becomes evident that the productivity rates in 1969 and 1970 were not sufficient to cause the population to rebound immediately. Even at a recruitment rate of 22% female lambs in December 1969, the population did not increase. The September 1970 survey indicated no increase in ewes classified over those classified in March 1969. The last survey of August 1971, however, indicated a slight increase in the number of ewes classified. Although the number of ewes observed in August 1971 was still about 50 less than was observed at the same period in 1968, it is apparent that the population was able to stabilize from the die-off of the 1968–1969 winter.

Causes for the apparent decline in the 1968–1969 winter are not immediately evident. There had been no real change in livestock grazing practices up to 1968 and the conditions under which the bighorn were living in the winter of 1968–1969 were the same conditions that had prevailed during previous decades. Starting in the winter of 1969–1970 there was a change in livestock management. No livestock were released onto the Junction area in 1969–1970, in 1970–1971 250 brood cows with calves were turned out only during April 1971, and in 1971–1972 about 300 heifers were turned out for only one month from March 15 – April 14.

Indications are that Deer Park and Cotton Ranches have not changed their management scheme in recent times. Deer Park winters 400 head of stock, 200 of which are brood cows and bulls. Cotton Ranch winters about the same number on the grasslands of the Fraser River.

Snow conditions were quite severe during the winter of 1968–1969. It was one of the few years in recent times when the snow did not blow off the slopes used by the bighorn on which to winter. Approximately 2 feet of snow lay on the range in December and January. These abnormal snow conditions, coupled with the previously observed severely overgrazed ranges, could have been the causal factors of the apparent decline.

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Literature Cited

Anonymous. 1967. History and legends of the Chilcotin. Caribou Press Limited, Williams Lake, British Columbia. 48 pp.

Blood, D. A. 1961. An ecological study of California bighorn sheep (*Ovis canadensis californiana* (Douglas) in southern British Columbia. Master of Science Thesis, University of British Columbia. 127 pp.

British Columbia Department of Agriculture. 1961–1970. Climate of British Columbia reports for 1961 to 1970 inclusive. Tables of temperature, precipitation, and sunshine. Publication Branch, Department of Agriculture, Victoria, British Columbia.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildlife Monographs, Number 4. 174 pp.

Cowan, I. McT. 1940. Distribution and variation in the native sheep of North America. American Midland Naturalist 24(3): 505–580.

Daubenmire, R. F. 1959. A canopy coverage method of vegetational analysis. Northwest Scientist 33(1): 43–64.

Daubenmire, R. F. 1968. Plant communities: text book of plant synecology. Harper and Row, New York. 300 pp.

Geist, V. 1971. Mountain sheep: a study in behaviour and evolution. University of Chicago Press, Chicago. 383 pp.

Haines, F. 1938. The northward spread of horses among the Plains Indians. American Anthropologist 40: 429–437.

Harper, F. E. 1969. Effects of certain climatic factors on the productivity and availability of forages on the Ashnola bighorn winter ranges. Master of Science Thesis, University of British Columbia. 112 pp.

Hobson, R. P., Jr. 1951. Grass beyond the mountains: discovering the last great cattle frontier on the North American continent. J. B. Lippincott Company, New York.

Holland, S. S. 1964. Land forms of British Columbia, a physiographic outline. British Columbia Department of Mines and Petroleum Resources, Bulletin Number 48. 138 pp.

Lamb, W. K. (Editor). 1960. The letters and journal of Simon Fraser 1806–1808. MacMillan Company, Toronto. 292 pp.

Laude, H. M. 1964. Plant responses to high temperatures. *In* Forage plant physiology and soil-range relationships. American Society of Agronomy Special Publication Number 5. pp. 15–31.

McCullough, D. R. and **E. R. Schneegas.** 1966. Winter observations on the Sierra Nevada bighorn sheep. California Fish and Game 52(2): 68–84.

McLean, A. and **E. W. Tisdale.** 1972. Recovery rate of depleted range sites under protection from grazing. Journal of Range Management 25(3): 178–184.

McIlvanie, S. K. 1942. Carbohydrate and nitrogen trends in bluebunch wheatgrass, *Agropyron spicatum*, with special reference to grazing influences. Journal of Plant Physiology 17(4): 540–557.

Morice, A. G. 1903. The history of the northern interior of British Columbia. 3rd Edition. John Lane, London, 368 pp.

National Soil Survey Committee of Canada. 1965. Report on the sixth meeting of the National Soil Survey Committee of Canada. Laval University, Quebec. 132 pp.

Poulton, C. E. and **E. W. Tisdale.** 1961. A quantitative method for the description and classification of range vegetation. Journal of Range Management 14(1): 13–21.

Ross, W. R. 1914. Report of the Minister of Lands for the Province of British Columbia, year ending December 31, 1913. King's Printer, Victoria, British Columbia.

Sherman, R. S. and **F. Perry.** 1936. Insect and plant associations in the Chilcotin. *In* Report of the Provincial Museum of Natural History for the year 1935. King's Printer, Victoria, British Columbia.

Spalding, D. J. and **J. N. Bone.** 1969. The California bighorn sheep of the South Okanagan Valley, British Columbia. British Columbia Fish and Wildlife Branch, Wildlife Management Publication 3. 45 pp.

Spalding, D. J. and **H. B. Mitchell.** 1970. Abundance and distribution of California bighorn sheep in North America. Journal of Wildlife Management 34(2): 473–475.

Stelfox, J. G. 1971. Bighorn sheep in the Canadian Rockies; History 1800–1970. Canadian Field Naturalist 85(3): 101–122.

Stoddart, L. A. and **A. D. Smith.** 1955. Range management. Second edition. McGraw-Hill Book Company Incorporated, Toronto. 433 pp.

Sugden, L. S. 1961. The California bighorn in British Columbia with particular reference to the Churn Creek Herd. British Columbia Department of Recreation and Conservation, Queen's Printer, Victoria, British Columbia. 58 pp.

Thomsen, L. B., L. P. Guichon and **E. W. Tisdale.** 1938. Report of the committee to investigate range matters in the Riske Creek Area. Report to Chief Forester of British Columbia Forest Service. 15 pp.

Toner, G. C. 1946. Notes on the mammals of the Lower Chilcotin River Region, Cariboo District, British Columbia. The Canadian Field Naturalist 60: 86–89.

Weir, T. R. 1964. Ranching in the Southern Interior Plateau of British Columbia. Geographical Branch, Mines and Technical Surveys. Memoir 4. Ottawa, Queen's Printer. 165 pp.

Williams, A. B. 1926. Game trails in British Columbia: big game and other sport of the wilds of British Columbia. Charles Scribner's Sons, New York. 360 pp.

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Notes

Design of a Tracking and Observation Station for Small Mammal Studies

Direct observation and study of small mammals in the field is a difficult and tedious task. A tracking station and feeder was designed, which has the advantages of allowing for direct observation, low cost, and easy field set-up and maintenance. This new design enables one to locate suitable observation positions rapidly and can increase the number of data acquired in any period several-fold.

The station consists of a piece of exterior plywood, 40 × 40 × 2 cm, on which are mounted four clear plastic tunnels leading to a feeder (Figure 1). The tunnels are made from long plastic boxes, 6.5 × 7 × 22 cm, manufactured by the Tristate Plastic Company, Box 337, Henderson, Kentucky, 42420. A box (with cover) is cut in half to make two tunnels. A hole approximately 6 cm in diameter is bored in the closed end of the tunnel and the whole unit is then mounted (with the cover down) on the board by means of rubber bands stretched from small nails. A glass jar with a plastic top is used as the food dispenser. A small hole is cut in the top to allow the food to run out; the jar is mounted in the center of the board on a small raised platform with four small openings to the tunnels. The tunnel floor, formed by the box cover, is flooded with a solution of alcohol and talcum powder (concentration 25% by volume) to record tracks of animals visiting the apparatus. The alcohol evaporates leaving an even coating of talcum. Extra coated bottoms can be prepared in advance

FIGURE 1. Tracking and observation station.

so that used bottoms can be replaced quickly and taken to the laboratory for detailed study. Preparation in the field is made easy by means of a small squirt-bottle containing the tracking solution; this method avoids smudging in transit.

The design of the apparatus permits direct observation of the animals visiting it, and protects the tracking medium in inclement weather. At night a red-light source is used. The apparatus also provides indirect data on the activity and movements from the numbers and positions of tracks, with identification of individuals by means of toe-clipping. Intensity of use of the feeder may be estimated by noting the number of tracks on the tracking plate. In addition, by recording weights of the food supply before and after specified periods, food consumption can be used as a measure of activity, population levels, or other parameters. By using grain dyed different colors at different stations, followed by searches for caches or stomach examination of snap-trapped individuals, data on movements could also be obtained.

Smaller units consisting of the entire box with holes cut in each end may also be used as tracking and observation stations. A small amount of food placed in the middle of the box attracts animals onto the tracking plate. Large numbers of such units checked at appropriate intervals provide a good measure of activity.

I have used this device with success in southern Florida and the Mojave Desert. In the latter locality intraspecific aggression was studied in the long-tailed pocket mouse (*Perognathus formosus*), and dominance behavior resulting in one individual excluding all others from the feeder after a matter of a few minutes was observed. Information on the ability of the canyon mouse (*Peromyscus crinitus*) to gather and store large amounts of food concentrated in one area, a natural situation in the desert where individual plants will often produce great numbers of seeds, has also been obtained with this apparatus.

I thank Dr. James N. Layne and Merle L. Knudson for critical reading of the manuscript, and Owen Minnick for aid in the construction of the feeder. This device was developed while the author was a participant in the Undergraduate Research program of the American Museum of Natural History at the Archbold Biological Station, Lake Placid, Florida.

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Northernmost Record of the Black-billed Magpie in Canada

An adult female Black-billed Magpie (*Pica pica*) was shot on May 13, 1972 by Wallace Lucas, a trapper at Sachs Harbour, Banks Island, Northwest Territories (72°00′ N, 125°00′ W). The bird appeared to be in good condition as shown by the amount of abdominal fat and the absence of internal parasites. The gizzard contained pieces of eggshell, grit, and flesh. A few lice were collected and tentatively identified as *Brueelia,* probably *biocellata* (W. B. Mountain, Entomology Research Institute, Canada Department of Agriculture, personal communication). The magpie's tail feathers exhibited fault bars (Hamerstrom, Frances. 1967. On the use of fault bars in ageing birds of prey. Inland Bird Banding Association News 39(2): 35–41), indicating previous exposure to some form of stress.

The previous published northernmost record of the species was reported by J. E. Bryant (1959. Magpie specimen from Wrigley, N.W.T. Canadian Field-Naturalist 73(3): 177) on the basis of one shot near Wrigley, N.W.T. (63°07′ N, 123°37′ W). T. Barry (personal communication) collected a Black-billed Magpie at Cape Parry (70°10′ N, 124°40′ W) in 1966 about 80 miles south southwest of Cape Lambton, Banks Island. He saw one near the Norman Wells Airport in 1962.

The occurrence of the species at Sachs Harbour, therefore, is some 600 miles north of the previously published northernmost North American record and is the first account of the Black-billed Magpie in the Canadian Arctic Archipelago.

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Growth Rates of Pikas in Alberta

Several aspects of the biology of pikas *Ochotona princeps* (Richardson) have been studied in southwestern Alberta (Millar 1970, 1972; Millar and Zwickel 1972a, b; MacArthur and Wang 1973). During the course of these studies, weights of wild juveniles were recorded from two study areas; Gibraltar Mt., Bow Forest (J.S.M.) and Plateau and Livingston Mts., Crowsnest Forest (S.C.T.). These data, along with weights of captive juveniles (J.S.M.), were examined to determine the rate of growth of young pikas and to develop a weight–age scale that could be used to estimate the age of live pikas during the summer of their birth.

General characteristics of the study areas have been described previously (Millar 1972). The Bow Forest study area consisted of several rock slides on the north side of Gibraltar Mountain (6000′), while the Crowsnest forest study areas consisted of one rock slide near Livingston Mountain (6000′) and one on Plateau Mountain (7000′). Juvenile animals on these areas were captured in 10 × 10 × 36-cm Sherman traps baited with green vegetation. All animals were individually marked with colored plastic ear tags, and periodically recaptured during the summer of their birth. At each capture the animals were weighted to the nearest gram with Pesola spring scales. Weight records of 49 juveniles were obtained in this way.

Soon after weaning 11 juveniles were captured from one rock slide on Gibraltar Mountain and housed in the field in 25 × 90-cm plexiglass cages. These animals were provided with a 6 × 6 × 6-cm nest box, water, and an abundance of green vegetation of the type frequently eaten in the wild. Weights of these animals were recorded at capture, and then at approximately 3-day intervals.

One juvenile was maintained under similar conditions in a 125 × 125-cm plywood cage.

One adult female housed in a 125 × 125-cm plywood cage gave birth to two young July 1, 1970, and successfully raised them to weaning.

Absolute age-weight relationships were known only for the two young born in captivity. Therefore the growth scale was developed from known weight gain over known time intervals for the wild juveniles of unknown age. The scale was developed as follows. Capture weights and recapture weights within 2–10 days of each other were used to calculate growth rates over these known time intervals. Two to 10 days was chosen because a 1-day interval was insufficient to show weight gain accurately, and periods over 10 days reflected a decreased rate of gain with age. These growth rates were then grouped, on the basis of initial weights, into 10-g intervals (eg. 31–40 g; 41–50 g). Mean initial weights and mean growth rates were determined for each weight interval. A comparison of mean growth rates between captive and wild juveniles (Table 1) indicated that animals housed in small cages had depressed growth rates. Data from animals in small cages were therefore omitted. Animals in large cages had slightly lower growth rates than wild animals, but the differences were not statistically significant. Data from animals in large cages were therefore combined with the data from wild animals. The growth curve was constructed graphically by using the mean rate of gain from one mean initial weight to the next to obtain the elapsed time. This curve started at birth, and 10 g was considered to be the birth weight (the two young born in captivity were 9.6 and 10.1 g and the four heaviest embryos from collected females were 9.3, 9.9, 10.1 and 11.4 g). The final or asymptotic weight was considered to be 133 g since the mean adult weight during May through August was 132.8 g ($N = 572$; range = 101–175).

The graphically constructed growth curve was then used to develop a growth equation following the method of Ricklefs (1967). The data best fit the von Bertalanffy growth curve and are described by

$$W = 133\ (1 - 1/3e^{-.0405(t-14)})^3$$

where W = weight in grams and t = age in days. This curve is presented along with the graphically constructed curve in Figure 1.

The nature of the development of the curve does not indicate its accuracy as an aging technique, hence the variability of the data was examined.

Animals were aged by the von Bertalanffy growth equation on the basis of their first weight record, and then subsequent weights over known time intervals were plotted to determine the extent that their subsequent growth deviated from the curve (Figure 2). The deviation of these points from the predicted curve indicated that animals 40 days of age or younger were within ±8 g of the predicted weight. This 8 g variation

TABLE 1. — Mean growth rates of wild and captive juvenile pikas in Alberta. Growth rates are averaged over a period of 2–10 days from each initial weight interval; sample size in brackets.

Initial weight interval (g)	Subsequent growth rate (g/day)		Wild
	Small cages (25 × 90 cm)	Large cages (125 × 125 cm)	
10–20		2.27 (4)	
21–30		1.33 (2)	
31–40		1.46 (4)	2.67 (1)
41–50	1.44 (3)	2.60 (2)	3.12 (1)
51–60	1.55 (4)	2.67 (2)	2.97 (3)
61–70	1.43 (7)	1.67 (3)	2.28 (10)
71–80	0.64 (21)	1.74 (4)	1.85 (18)
81–90	0.43 (25)	1.37 (4)	1.87 (11)
91–100	0.55 (6)		1.79 (9)
101–110	0.41 (4)		0.70 (9)
111–120			0.53 (10)
121–130			−.84 (2)

NOTE: No significant difference between animals in large cages and wild juveniles in the 61–70 ($t = 1.906$; $P > .05$), 71–80 ($t = 0.158$; $P > .50$), or 81–90 ($t = 0.0685$; $P > .50$) initial weight intervals.

at day 40 indicated that age estimates of juveniles were within about ±6 days of the growth curve. Animals older than 40 days varied a great deal more.

The scale was also tested by predicting the age and calculating the date of birth for 24 litters containing two or more juveniles. All animals were younger than 40 days and the predicted dates of birth for each litter varied by an average of ±2.2 days (range 0–8).

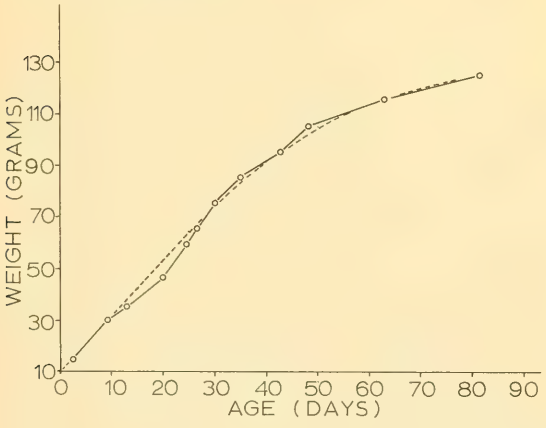

FIGURE 1. Graphically projected growth curve for pikas in Alberta (solid line) and curve projected from the growth equation $W = 133(1 - 1/3e^{-0.0405(t-14)})^3$ (broken line).

Some of this variation was due to variable weights of animals. Juveniles captured two or more times in the same day varied up to ±3 g ($N = 7$; $X = 1.4$) if 40 days of age or less, and varied up to ±8 g ($N = 8$; $X = 3.0$) if older than 40 days.

In general, body weights of juveniles up to 40 days of age appear to provide estimates of age

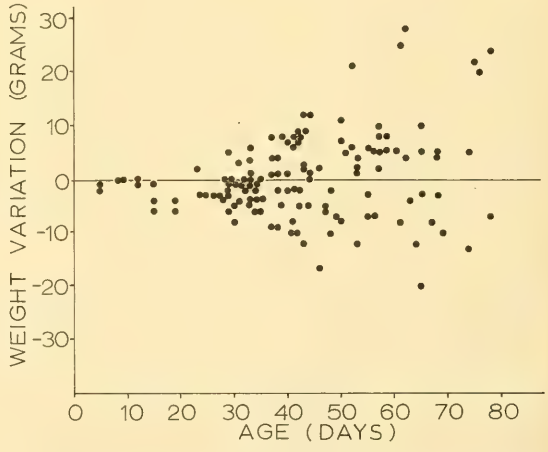

FIGURE 2. Deviation of weights of juveniles from the predicted growth curve. Juveniles were aged on the basis of the first weight record, and their subsequent weights were plotted as deviations from the predicted age.

that are accurate to within about one week. Age-weight relationships of animals between 15 and 50 days of age are presented in Table 2.

The value of this growth curve as an aging technique for pikas in other areas is unknown. Severaid (1955) reported weaning at 3–4 weeks of age in California. In Alberta animals were active out of the nests by the third week of age (Figure 3) and growth rates may be faster in Alberta.

TABLE 2. — Body weight for ages 15–50 days, predicted from the equation

$$W = 133\left(1 - \frac{1}{3}e^{-.0405\,(t-14)}\right)^3$$

Age (days)	Weight (grams)
15	42.4
16	44.1
17	46.5
18	48.9
19	51.2
20	53.6
21	55.8
22	58.1
23	60.3
24	62.5
25	64.7
26	66.8
27	68.8
28	70.9
29	72.9
30	74.8
31	76.7
32	78.1
33	80.4
34	82.1
35	84.1
36	85.5
37	87.1
38	88.7
39	90.3
40	91.8
41	93.2
42	94.6
43	96.0
44	97.3
45	98.6
46	99.8
47	101.0
48	101.9
49	103.3
50	104.4

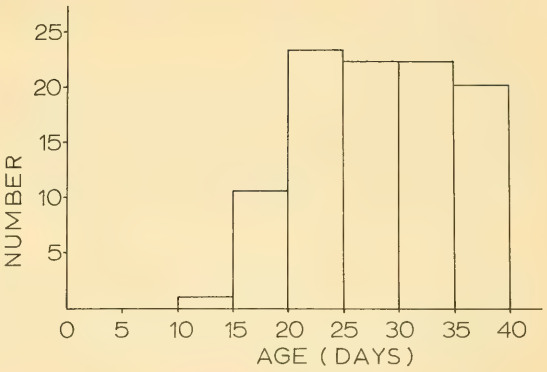

FIGURE 3. Age distribution of juvenile pikas in Alberta, based on first weight records of live trapped animals, and weights of collected juveniles. The smallest animal (32 g) was likely older than the estimated age of 11 days.

Acknowledgments

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Literature Cited

MacArthur, R. A. and **L. C. H. Wang.** 1973. Physiology of thermoregulation in the pika, *Ocotona princeps*. Canadian Journal of Zoology 51: 11–16.

Millar, J. S. 1970. Adrenal weights in relation to reproductive status in the pika, *Ochotona princeps* (Richardson). Canadian Journal of Zoology 48: 1137–1140.

Millar, J. S. 1972. Timing of breeding of pikas in southwestern Alberta. Canadian Journal of Zoology 50: 665–669.

Millar, J. S. and **F. C. Zwickel.** 1972a. Characteristics and ecological significance of hay piles of pikas. Mammalia 36: 58–68.

Millar, J. S. and **F. C. Zwickel.** 1972b. Determination of age, age structure, and mortality of the pika *Ochotona princeps* (Richardson). Canadian Journal of Zoology 50: 229–232.

Ricklefs, R. E. 1967. A graphical method of fitting equations to growth curves. Ecology 48: 978–983.

Severaid, J. H. 1955. The natural history of the pika (Mammalian genus *Ochotona*). Ph.D. thesis, University of California, Berkeley, California. 820 pp.

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Vegetative Distinctions in Canadian Species of *Mitella* and *Tiarella*[1]

Abstract. Petiole hair characters serve to separate foliage of *Mitella diphylla* (miterwort) and *Tiarella cordifolia* (foam flower), help to separate the five species of of *Mitella* in western Canada, and demonstrate introgression between *Tiarella laciniata* and *T. trifoliata* more clearly than does leaf shape.

The host plants of rust fungi are often not reliably determined. Sometimes the specimens are collected late in the season when flowers or fruit are scarce; but often the collector, through overconfidence in his diagnostic ability, simply omits flowers or fruit that may occur. In a current revision of some rusts of Saxifragaceae I found reason to doubt the names applied to various *Mitella* and *Tiarella* specimens. The leaves of phanerogamic specimens of the species in question were accordingly examined in a search for new characters. The petiole hairs proved to provide such characters. The findings are presented here as an aid to mycologists, ecologists, or others who may need to identify vegetative material.

In eastern Canada *Mitella nuda* is confined to the boreal forest. Thus the only serious problem is to distinguish *M. diphylla* and *Tiarella cordifolia,* which have a broad ecogeographic overlap in the hardwood forests. The leaves of *T. cordifolia* tend to have more rounded teeth and to contain more anthocyanin than those of *M. diphylla;* but these variable characters are of little help if the plants are not associated. Examination of numerous sheets of both species from Ontario and Quebec, and of shorter series from the rest of their ranges, showed that their petiole pubescence is consistently distinct. Adjacent to the blade the distinctions are not always sharp, but near the middle of the petiole they are strong and constant.

The hairs of *Tiarella cordifolia* grade imperceptibly from sessile or subsessile red glands to long, flexuous and slender hairs that are initially gland-tipped (the glands seem to weather off in age). The long hairs are white except in weathered or poorly dried specimens, and are randomly oriented, or at most, gradually and irregularly *decurved* (Figure 1, right).

On the petioles of *Mitella diphylla* the hairs are of two distinct types: (*a*) sessile to short-stalked glands; and (*b*) stiff, long and stout white hairs that *deflex* abruptly at the base about 30 to 90° from the horizontal (in the last case being appressed to the petiole) (Figure 1, left).

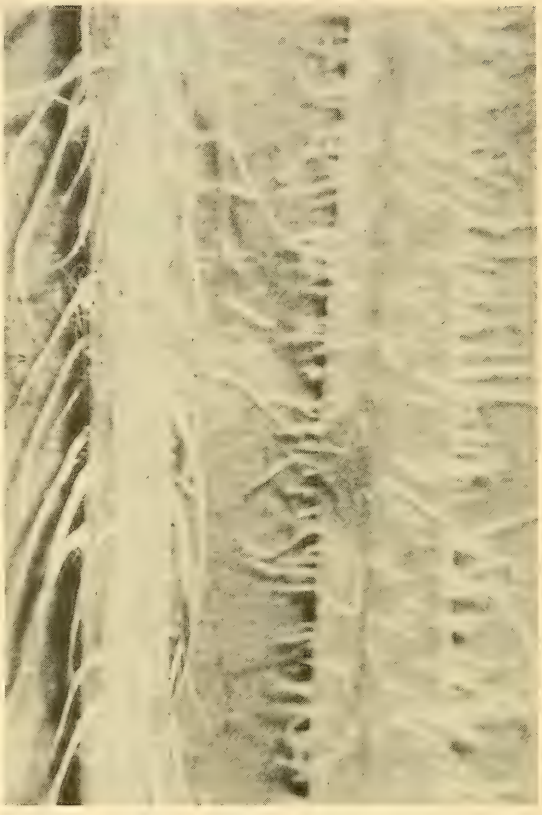

FIGURE 1. Left — Petiole of *Mitella diphylla,* showing subsessile glands and stiff, long, deflexed hairs, without intermediates. Right — Petiole of *Tiarella cordifolia,* showing gradation from subsessile glands to long flexuous hairs; the latter are often variously decurved but never abruptly deflexed.

On overwintered green leaves much of the pubescence may have weathered off, but usually enough long hairs persist to allow confirmation of the plant's identity under the dissecting microscope or a X14 hand lens. Rarely a plant is seen in which individual petioles vary slightly from the norm, but when all petioles are checked determination has never been difficult. Identification of material that is both weathered and fragmentary might rarely be inconclusive.

[1]Contribution Number 972, Plant Research Institute.

TABLE 1. — Petiole hair types of *Mitella* spp. in western Canada

Mitella species	Sessile or subsessile glands	Long flexuous hairs*	Rigid, deflexed white hairs
breweri	Few near blade or nil	Abundant, ± decurved, drying brown	Nil
nuda	Few near blade or nil	Few to many, especially near blade, decurved, white	Nil
ovalis	Nil, or rarely few at blade	Few except near blade, ± decurved, drying yellow-brown	Nil
pentandra	Nil, or rarely few near blade	Few except occasionally near blade, ± decurved, whitish to brown	Nil
trifida	Abundant	Nil	Abundant

*In this character white vs. brown refers to adequately dried specimens; with bad preparation nearly all hairs of this type are brown.

In western Canada no species of *Mitella* can rationally be confused with any species of *Tiarella;* but within each genus interspecific distinctions are not always obvious, notably in late-season *Mitella* specimens that lack petals. The leaf shapes of the five species of *Mitella* found in western Canada are partly diagnostic, and the shapes, but not pubescence, are well illustrated in C. L. Hitchcock et al. (1961. Vascular plants of the Pacific Northwest. Part 3. Seattle, Washington). The petiole hair characters, combined with leaf shape, allow almost all specimens to be determined positively. For simplicity the characters are tabulated herewith (Table 1). It is seen that the hairs of *M. trifida* closely match those of the eastern *M. diphylla,* readily separating it from the other western species. The differences between the remaining species are only quantitative and less useful. In *M. nuda* the hairs much resemble those of *Tiarella cordifolia,* but are generally much less abundant except adjacent to the blade. In *M. breweri* the subsessile glands are also few and in *M. ovalis* and *M. pentandra* they are always absent except rarely near the blade. *Mitella breweri* and *M. pentandra* share the character of flexuous hairs that dry brown; and *M. pentandra* varies in this character. It must be emphasized that hair color has been recorded only for specimens (notably those of J. A. Calder and his colleagues) in which it is known that the specimens were dried promptly, with good ventilation and gentle heat. For poorly-dried specimens there is no assurance that normally white hairs will remain so.

The three western species of *Tiarella, T. laciniata, T. trifoliata,* and *T. unifoliata,* have, as their names imply, deeply incised, trifoliate, and lobed but undivided leaves, respectively. Typical plants are very distinctive; but on Vancouver Island, where their ranges overlap, *T. laciniata* and *T. trifoliata* sometimes hybridize, with subsequent introgression. *Tiarella laciniata* petioles have abundant gland-tipped white hairs, of which the longest are conspicuously flexuous and often somewhat decurved; thus the petioles closely resemble those of *T. cordifolia.* In *T. unifoliata* and in typical *T. trifoliata* there is a modest production of short to moderately long (but straight) hairs near the lamina; but for most of the petiole length there are only short-stalked to sessile glands, and often these are so sparse that the petiole may appear glabrous to the naked eye. On Vancouver Island some demes of *T. trifoliata* have pubescence nearly as abundant as in *T. laciniata.* Some of these plants have leaf blades somewhat more incised than usual, and clearly are derived in part from *T. laciniata;* but others have leaf blades typical of *T. trifoliata,* and only the petiole pubescence indicates introgression of *laciniata* genes. Significantly, a few specimens from the mainland near Vancouver are of this type. I suspect that *T. laciniata* was in this region during the Hypsithermal Interval, and that, since its retreat, the *laciniata* type of petiole hair has persisted. Thus these hairs may be the more sensitive indicator of such introgression.

The fact that the petiole hair types do not fully correlate with the generic distinctions emphasizes the close relationship of *Mitella* and *Tiarella.*

The study is based on the following number of sheets, with an average of about two plants per sheet: *Mitella diphylla* 186, *M. breweri* 30, *M. nuda* ca. 120, *M. ovalis* 17, *M. pentandra* 101, *M. trifida* 56, *Tiarella cordifolia* ca. 250, *T. laciniata* 13, *T. laciniata* × *trifoliata* 15, *T. trifoliata* 118, *T. unifoliata* 126. The specimens cover most of the range of each species, not merely the Canadian range. Various cultivated and mycological specimens are not included in these totals.

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The Rare Green Alga *Pectodictyon cubicum* Taft in Ontario

Pectodictyon cubicum Taft, a rare member of the Chlorococcales (Scenedesmaceae), was originally described by C. E. Taft (1945) from Kelleys Island, Ohio, in the western part of Lake Erie. The characteristic shape of the colony, with the cells occupying the corners of a cube and held together by gelatinous strands, make this an easy genus to recognize. It has been recorded, however, only two or three times. Prescott (1954) stated that it had been collected once since its description. This record could not be located in the literature but may refer to the culture isolated by Starr (1964) for the Indiana University Culture Collection of Algae. It has also been collected from a water-supply reservoir at Salem, Washington County, Indiana (Palmer and Brown 1960). Taft and Taft (1971) have listed the type collection again in their review of Lake Erie algae.

Pectodictyon cubicum was present in a collection made on November 6, 1971 from the Bruce Peninsula. The collection site was a small pond by the side of Highway 6 about 3.5 miles south of Tobermory, Ontario. The pond bottom was covered with an extensive growth of *Chara* sp. Two colonies of the alga were observed and isolated into biphasic soil–water medium. One of the isolates grew but growth in culture was very poor and the culture died after a few transfers.

The alga in collections has the typical cubical shape but in culture the daughter cells tended to remain attached to the parent cube with the result that extensive colonies of interconnected cubes were produced. Cells are spherical and measure 8–10 μm in diameter, slightly larger than those of Taft (1945). The size of a colony cube, measured along one of the gelatinous strands, was about 30 μm in collections and up to 100 μm in culture.

The pond was visited again on October 26, 1972. *Pectodictyon* was present in two collections made from the pond and in greater quantities than in 1971, although still in very low numbers. Several isolations were made into various standard culture media and one of the isolates in biphasic soil–water medium established a clone which grows much better than the 1971 isolate. Further studies on *Pectodictyon* are contemplated.

Literature Cited

Palmer, C. M. and **E. Brown.** 1960. *Pectodictyon* and other unusual algae from Indiana. Proceedings of the Indiana Academy of Science 69: 119–122.

Prescott, G. W. 1954. How to know the freshwater algae. William C. Brown, Dubuque, Iowa.

Starr, R. C. 1964. The culture collection of algae at Indiana University. American Journal of Botany 51: 1013–1044.

Taft, C. E. 1945. *Pectodictyon,* a new genus in the family Scenedesmaceae. Transactions of the American Microscopical Society 64: 25–28.

Taft, C. E. and C. W. Taft. 1971. The algae of western Lake Erie. Bulletin of the Ohio Biological Survey, New Series 4(1): 1–185.

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Annotated Records of Some Dragonflies (Odonata) from Ontario

Our knowledge of the systematics, ecology, and distribution of Canadian odonates is due largely to the work of E. M. Walker, a student of Canadian odonates for over 50 years. During May and June 1972, I was briefly able to observe and collect dragonflies from lakes and ponds with marshy, vegetated zones in Ontario, especially in the vicinity of Waterloo, (43°30′ N; 80°32′ W). These records are compiled herein with information on the locality, type of material, and date collected, observations and remarks. Unless specifically stated otherwise, these records corroborate the notes of Walker and others (Walker 1941, 1953, 1958; Walker and Corbet, in press) and reviews of the biology of odonates by Corbet (1962) and Corbet et al. (1960).

COENAGRIONIDAE

Coenagrion resolutum (Hagen).

Spongy Lake (Petersburg, Waterloo Co.): adults (1 ♂) on 26 May 1972. Mer Bleue (Carlsbad Springs, Carleton Co.): adults (1 ♂) on 2 June 1972. Adults fly close to the water, near the shore, and use emergent grasses as perches.

Enallagma boreale Selys.

Calabogie Lake (Calabogie, Renfrew Co.): adults (2 ♂, 1 ♀), adults (2 ♀) reared from larvae and one pair copulating on 3 June 1972. Adults perch on reeds (*Typha* sp.) and grasses, with males confronting and chasing conspecific males. Copulation occurs on a reed perch as in *Enallagma civile* (Hagen) (Bick and Bick 1963).

Enallagma clausum Morse.

Sharbot Lake (Sharbot Lake, Frontenac Co.): adults (1 ♂) on 2 June 1972. Adults occur in the marshy backwaters, and use grasses and reeds as perches. This species has been recorded hitherto only from Nipissing County in Ontario (Walker 1953).

Enallagma hageni (Walsh).

Big Clear Lake (Arden, Frontenac Co.): adults (4 ♀) emerged from larvae on 2 June 1972. Larvae occur on submerged vegetation in shallow bays, and emerge at the water surface on vertical substrates (grasses).

Enallagma vernale (Gloyd).

Luther Lake (Monticello, Dufferin Co.): larvae collected on 13 May 1972 emerged (3 ♂) on 26–28 May 1972. Fowler Lake (Eastwood, Oxford Co.): adults (1 ♂), adults (1 ♂, 1 ♀) emerged from larvae, one pair copulating and one pair ovipositing on 7 June 1972. Big Clear Lake (Arden, Frontenac Co.): adults (1 ♂) emerged from larvae on 2 June 1972. Larvae occur on submerged vegetation in shallow bays, and emerge on vertical substrates (grasses and reeds) up to 1 cm above the water surface.

Ischnura verticalis (Say).

Miller's Lake (Ayr, Waterloo Co.): adults (1 ♂, 1 ♀) emerged from larvae on 25 May 1972. Fowler Lake (Eastwood, Oxford Co.): larvae emerging into adults (sighted), adults (1 ♂), two pairs copulating and two pairs ovipositing on 7 June 1972. Big Clear Lake (Arden, Frontenac Co.): (1 ♂) emerged from larva on 2 June 1972. White Lake (White Lake, Renfrew Co.): adults (1 ♂) and one pair copulating on 3 June 1972. Larvae occur on submerged vegetation near the shore and emerge on vertical substrates (grasses) up to 1 cm above the water surface. Adult males occupy perches of grass near the water, and from this base they patrol an area in the vicinity, and confront and chase conspecific males. Copulation occurs on a perch similar to the male perch, and oviposition occurs in tandem at the water surface, as observed by Grieve (1937).

AESHNIDAE

Anax junius Drury.

Pinehurst Lake (Paris, Brant Co.): adults (2 ♂ sighted) on 28 April 1972, 10 May 1972, 22 May 1972, 28 May 1972.

Fowler Lake (Eastwood, Oxford Co.): adults (males sighted) and two pairs ovipositing on 7 June 1972. Roadside pool near Cranberry Bog (Ayr, Waterloo Co.): one pair ovipositing on 11 May 1972. Miller's Lake (Ayr, Waterloo Co.): adults (1 ♂) and one pair ovipositing on 11 May 1972. Spongy Lake (Petersburg, Waterloo Co.): adults (1 ♂) and one pair ovipositing on 26 May 1972. Luther Lake (Monticello, Dufferin Co.): adults (1 ♂, 1 ♀) and one pair ovipositing on 13 May 1972. Adults occur at sheltered bays with emergent and surface vegetation, with males occurring at densities of two to six individuals per 50 m shore length. Males occupy specific perches at the water (usually a reed or twig), and patrol a length of shoreline, and chase conspecific males. Oviposition occurs in tandem, in decaying vegetation or surface plants. The early population of this species is a nonresidential one (Trottier 1966, 1971), and its appearance in late April, and oviposition in late May, is considerably earlier than the early July recorded by Trottier.

GOMPHIDAE

Gomphus (*Arigomphus*) *furcifer* Hagen.

Calabogie Lake (Calabogie, Renfrew Co.): adults (2 ♂, 2 ♀) emerged from larvae and six exuviae on 3 June 1972. Larvae emerge on horizontal substrates (mud bank or water lily leaf) at the water surface. This species has not been recorded previously as far north as Renfrew county (Walker 1958).

Gomphus (*Gomphus*) *spicatus* Hagen.

Sunset Lake (Crief, Wentworth Co.): adults (1 ♂) emerged from larvae on 24 May 1972, and adults (4 ♂, 2 ♀), about 70 exuvia and adults (3 ♀) emerged from larvae on 26 May 1972. Fowler Lake (Eastwood, Oxford Co.): adults (1 ♂) on 7 June 1972. Larvae occur on muddy substrates with leaves, and emerge at the water surface on horizontal substrates (mud, grasses, etc.). Newly-emerged adults bask on roads and clearings in the vegetation within 200 m of the emergence site. Adult males occupy a woody perch near the water and patrol about 20 m of the shoreline.

CORDULIIDAE

Cordulia shurtleffi Scudder.

Calabogie Lake (Calabogie, Renfrew Co.): adults (3 ♂) on 3 June 1972. Red Cedar Lake (Marten River, Nipissing Co.): five exuvia on 4 June 1972. Karol Lake (Timagami, Nipissing Co.): eight exuvia on 4 June 1972. Exuvia occur 20–30 cm above water on vertical substrates (shrubs, grasses, or reeds). Adult males rarely occupy a perch, and patrol a large territory along the shore and over the water, about 10 m long and 5 m wide. They confront and chase conspecific males, and are chased by males of *Libellula quadrimaculata* Linne and *Leucorrhinia intacta* Hagen.

Epitheca princeps Hagen.

Fowler Lake (Eastwood, Oxford Co.): emerging adults (one sex indeterminate) on 7 June 1972. Miller's Lake (Ayr, Waterloo Co.): larvae collected on 11 May 1972 emerged (1 ♀) on 28 May 1972. Larvae occur on submerged vegetation in sheltered bays, and emerge 10–30 cm above water on vertical substrates (twigs, reeds).

Epitheca cynosura (Say).

Fowler Lake (Eastwood, Oxford Co.): adults (2 ♂, 1 ♀) and one pair copulating on 7 June 1972. Big Clear Lake (Arden, Frontenac Co.): adults (3 ♂, 2 ♀) emerged from larvae and 22 exuvia on 2 June 1972. White Lake (White Lake, Renfrew Co.): adults (1 ♀) on 3 June 1972. Larvae occur on submerged vegetation and on muddy bottoms in sheltered bays, and emerge 20–30 cm above water on vertical substrates (reeds and grasses). Adult males rarely occupy a perch, patrol an area along the shore and over the water, and confront and chase conspecific males. Adult males are chased by males of *Libellula* (*Ladona*) *julia* Uhler, *Gomphus* (*Gomphus*) *spicatus* Hagen and *Anax junius*

Drury. They thus establish territories measuring about 6 m in length along the shore and 10 m in width over the water. Courtship is brief and within the territory. Copulation occurs on a perch outside the territory. The emergence and ecology of this species agree with that noted by Kormondy (1959), Lutz (1961), and Lutz and Jenner (1964).

Epitheca spinigera (Selys).

Miller's Lake (Ayr, Waterloo Co.): larvae collected on 11 May 1972 emerged (3 ♀) on 15–25 May 1972, six exuvia on 22 May 1972, and 19 exuvia on 25 May 1972. Isaac Lake (Mar, Bruce Co.): larvae collected on 19 May 1972 emerged (1 ♂, 7 ♀) on 19–26 May 1972. Larvae occur on aquatic vegetation in sheltered bays, and emerge on vertical substrates (reeds and twigs) 0–1 m above the water.

LIBELLULIDAE

Leucorrhinia intacta Hagen.

Sunset Lake (Crief, Wentworth Co.): adult (1 ♀) emerged from larvae and four exuvia on 26 May 1972. Pinehurst Lake (Paris, Brant Co.): adults (sighted) and one exuvium on 28 May 1972. Fowler Lake (Eastwood, Oxford Co.): adults (sighted), adults (1 ♂, 1 ♀) emerged from larvae, two exuvia, two pairs copulating and two pairs ovipositing on 7 June 1972. Miller's Lake (Ayr, Waterloo Co.): larvae collected on 11 May 1972 emerged (1 ♀) on 24 May 1972, larvae on 20 May 1972, and adults (2 ♂, 2 ♀) emerged from larvae on 25 May 1972. Spongy Lake (Petersburg, Waterloo Co.): adults (1 ♂) and two pairs ovipositing on 26 May 1972. Luther Lake (Monticello, Dufferin Co.): larvae collected on 13 May 1972 emerged (1 ♀) on 30 May 1972. Isaac Lake (Mar, Bruce Co.): larvae collected on 19 May 1972 emerged (1 ♂) on 23 May 1972. Calabogie Lake (Calabogie, Renfrew Co.): adults (2 ♂ 1 ♀) and one pair copulating on 3 June 1972. Red Cedar Lake (Marten River, Nipissing Co.): two exuvia on 4 June 1972. Karol Lake (Timagami, Nipissing Co.): two exuvia on 4 June 1972. Roadside pond (Timagami, Nipissing Co.): five exuvia on 4 June 1972. Larvae occur on aquatic vegetation and the bottom in sheltered bays, and emerge on vertical substrates (wood, grass, and reeds) 0–10 cm above water near the shore. Adult males occupy distinct perches of wood or vegetation, patrol the vicinity of the perch, and confront and chase conspecific males. Territories thus established measure 1–2 m in diameter. Courtship is brief, and copulation occurs in flight and on a perch outside the territory. During oviposition, the male hovers above the female and guards her against interference by other conspecific males; when interference by conspecific males is frequent, the female may cease oviposition, rest for a few minutes, and continue oviposition alone. Whitehouse (1941) records similar oviposition behavior, while Pajunen (1962a, b, 1963, 1964a, b, 1966) has studied the ecology of the related European species, *L. dubia* v.d. Lind., *L. rubicunda* L., and *L. caudalis* Charp.

Leucorrhinia patricia Walker.

Colton Lake (Rolphton, Renfrew Co.): adults (1 ♂) on 3 June 1972. Adult males occupy a perch and patrol the vicinity of this perch. This species has not been recorded from Renfrew county previously (Walker and Corbet, in press).

Libellula (*Ladona*) *julia* Uhler.

Fowler Lake (Eastwood, Oxford Co.): adults (5 ♂, 1 ♀), two pairs copulating and two pairs ovipositing on 7 June 1972. Calabogie Lake (Calabogie, Renfrew Co.): adults (2 ♂) and one pair ovipositing on 3 June 1972. Roadside pond (Timagami, Nipissing Co.): one exuvium on 4 June 1972. Karol Lake (Timagami, Nipissing Co.): four exuvia on 4 June 1972. Red Cedar Lake (Marten River, Nipissing Co.): six exuvia on 4 June 1972. Exuvia occur about 10 cm above the water on vertical substrates (shrubs and grasses). Adult males occupy a perch as base, patrol the area in its vicinity and chase away conspecific males, thus establishing territories about

2–3 m in maximum length. Courtship is brief, and copulation occurs outside the territory on a perch. During oviposition, the male guards the ovipositing female by hovering above her and chasing away conspecific males.

Libellula (*Plathemis*) *lydia* Drury.

Mer Bleue (Carlsbad Springs, Carleton Co.): larva emerged into adult (1 ♂) on 2 June 1971. Larvae emerge on vertical substrates (twigs and logs) 0–10 cm above water.

Libellula quadrimaculata Linne.

Calabogie Lake (Calabogie, Renfrew Co.): adults (4 ♂) on 3 June 1972. Adults hover high above water.

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I am grateful to Dr. P. S. Corbet (University of Waterloo) for making this field work possible, and for his advice throughout, and to the staff of the Department of Biology, University of Waterloo for their cooperation. This work would not have been possible without financial assistance from the University of Malaya, and funds to Dr. P. S. Corbet from the National Research Council, Canada (Grant No. A6586).

Literature Cited

Bick, G. H. and **J. C. Bick.** 1963. Behavior and population structure of the damselfly, *Enallagma civile* (Hagen) (Odonata: Coenagriidae). Southwestern Naturalist 8: 57–84.

Corbet, P. S. 1962. The biology of dragonflies. Witherby, London.

Corbet, P. S., C. Longfield and **N. W. Moore.** 1960. Dragonflies. Collins, London.

Grieve, E. G. 1937. Studies on the biology of the damselfly *Ischnura verticalis* Say, with notes on certain parasites. Entomologica americana 17: 121–153.

Kormondy, E. J. 1959. The systematics of *Tetragoneuria,* based on ecological, life history, and morphological evidence (Odonata: Corduliidae). University of Michigan Museum of Zoology, Miscellaneous Publications 107: 7–79.

Lutz, P. E. 1961. Pattern of emergence in the dragonfly *Tetragoneuria cynosura.* Journal of the Elisha Mitchell Scientific Society 77: 114–115.

Lutz, P. and **C. E. Jenner.** 1964. Life history and photoperiodic responses of nymphs of *Tetragoneuria cynosura* (Say). Biological Bulletin (Woods Hole) 127: 304–316.

Pajunen, V. I. 1962a. Studies on the population ecology of *Leucorrhinia dubia* v.d. Lind. (Odon., Libellulidae). Annals of Zoological Society Vanamo 24(4). 79 pp.

Pajunen, V. I. 1962b. A description of aggressive behaviour between males of *Leucorrhinia dubia* v.d. Lind. (Odon., Libellulidae). Annales Entomologici Fennici (Suomen Hyonteistieteellinen Aikakauskirja) 28: 108–118.

Pajunen, V. I. 1963. Reproductive behaviour in *Leucorrhinia dubia* v.d. Lind. and *L. rubicunda* L. (Odon., Libellulidae). Annales Zoologici Fennici 29: 106–118.

Pajunen, V. I. 1964a. Mechanism of sex recognition in *Leucorrhinia dubia* v.d. Lind., with notes on the reproductive isolation between *L. dubia* and *L. rubicunda* L. (Odon., Libellulidae). Annales Zoologici Fennici 1: 55–71.

Pajunen, V. I. 1964b. Aggressive behaviour in *Leucorrhinia caudalis* Charp. (Odon,. Libellulidae). Annales Zoologici Fennici 1: 357–369.

Pajunen, V. I. 1966. The influence of population density on the territorial behaviour of *Leucorrhinia rubicunda* L. (Odon., Libellulidae). Annales Zoologici Fennici 3: 40–52.

Trottier, R. 1966. The emergence and sex ratio of *Anax junius* Drury (Odonata: Aeshnidae) in Canada. Canadian Entomologist 98: 794–798.

Trottier, R. 1971. Effect of temperature on the life-cycle of *Anas junius* (Odonata: Aeshnidae) in Canada. Canadian Entomologist 103: 1671–1683.

Walker, E. M. 1941. List of Odonata of Ontario with distributional and seasonal data. Transactions of the Royal Canadian Institute 23: 201–265.

Walker, E. M. 1953. The Odonata of Canada and Alaska. Volume I. University of Toronto Press, Toronto. 292 pp.

Walker, E. M. 1958. The Odonata of Canada and Alaska. Volume II. University of Toronto Press, Toronto.

Walker, E. M. and **P. S. Corbet.** (*In press*). The Odonata of Canada and Alaska. Volume III. University of Toronto Press, Toronto.

Whitehouse, F. C. 1941. British Columbia dragonflies (Odonata), with notes on distribution and habits (with descriptions of two new nymphs by E. M. Walker). American Midland Naturalist 26: 488–557.

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Western Kingbird on the Tuktoyaktuk Peninsula, Northwest Territories

Ranford (1972) and Jonkel (1970) have summarized kingbird observations from northern portions of the arctic mainland in the Northwest Territories. The sightings were made on Southampton, Coats, and Bencas Island in the eastern Arctic, and at Bathurst Inlet and Norman Wells in the West. All observations were of the Eastern Kingbird (*Tyrannus tyrannus*). I have an unpublished record of an Eastern Kingbird that I found dead on June 28, 1960, on an island in the Thelon River, N.W.T. (64°27′ N, 101°34′ W).

From May 29 to June 16, 1972, a Canadian Wildlife Service crew was carrying out waterfowl studies from a base camp on Cape Dalhousie (70°15′ N, 129°40′ W), the extreme northeastern tip of the Tuktoyaktuk Peninsula. The spring was late and many arctic nesting waterfowl did not produce young in 1972. Except for the last few days of the above period, the low coastal tundra at Cape Dalhousie was covered with snow and ice, and some open water re-froze on June 16, which caused us to wonder if we were experiencing spring or fall.

On June 15, when returning to base camp, I saw a blackbird-sized bird, displaying a good deal of yellow on the belly and a blackish tail, suddenly fly over from the direction of our base camp about 200 yards away. I could not use my binoculars as I was carrying a load of driftwood. The bird quickly disappeared from view but I was convinced that it was a Western Kingbird (*Tyrannus verticalis*), although the possibility that it could have been a Cassin's Kingbird (*T. vociferans*), a similar species found in the western United States, could not be completely eliminated.

I reported my finding to the other crew members and we decided to look for the bird again. Our second effort was rewarded when we clearly saw the gray and yellow Western Kingbird perched on the ground near a male Lapland Longspur (*Calcarius lapponicus*). We observed the kingbird catching insects and then returning to perch on a hummock. During these brief fluttering flights we observed white or yellowish-white markings on the outer tail. This fieldmark confirmed our identification as that of the Western Kingbird. We did not hear the bird's shrill call. After a few minutes the bird flew west and was not seen again.

In Canada, the Western Kingbird nests only in the southern third of the prairie provinces, British Columbia, and perhaps in southern Ontario, and vagrants have been reported as far north as Newfoundland (Godfrey 1966).

Literature Cited

Godfrey, W. Earl. 1966. The birds of Canada. National Museum of Canada, Bulletin Number 203, Biological Series Number 73.

Jonkel, Charles J. 1970. A new northern record for the Eastern Kingbird. Canadian Field-Naturalist 84(3): 309–310.

Ranford, R. Barry. 1972. Eastern Kingbird on Southampton Island, N.W.T. Canadian Field-Naturalist 86(2): 166.

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Percina caprodes semifasciata, the Logperch, Newly Recorded in Alberta, and New Distribution Records for *Chrosomus neogaeus* and *Semotilus margarita*

One specimen of *Percina caprodes semifasciata* (DeKay), the logperch, was obtained on the afternoon of August 4, 1971 by W. E. Roberts and R. Leong while seining for forage fish at the mouth of the Medley River, tributary to Cold Lake, Alberta (54°36′ N, 110°12′ W). Previous extensive collecting by R. B. Miller (MS 1956. The management of the fish resources of Cold Lake. Mimeo. 10 pp.) and by Alberta Fish and Wildlife personnel between 1956 and 1971 had not yielded this species. Periodic seining along the lakeshore and river mouth earlier in 1971, combined with the rotenoning of the lagoon at the mouth, yielded 19 species of fishes but no *Percina*.

Etheostoma exile (Girard), the Iowa darter, is commonly found at the mouth of the Medley in May and June. Although easily seen in the shallow water, they are rarely collected owing to their

bottom-dwelling habits and the rocky uneven nature of the substrate that characterizes the greatest portion of the Medley River. The collection site was similar, except that its margins were sandy. Consequently, *Percina* may be more abundant than is indicated by the results of seine hauls.

Percina is recorded from Lac des Isles, Saskatchewan on the Waterhen River (Churchill system) but not in Pierce Lake, which lies between the former lake and Cold Lake (F. M. Atton, Saskatchewan Fisheries Laboratory, personal communication).

The specimen is deposited in the University of Alberta Museum of Zoology (UAMZ 3148). The following counts were noted: DXIV-14; A.II, 10; LL scales 80; LL pores 77. The naked area on the nape is rather extensive with a scaleless strip on each side of the front of the first dorsal fin to the region between spines III and IV. The lateral bands are irregular in width, and melanophores are more prevalent in the region of the lateral line. The naked nape and the nature of the lateral bands are in agreement with descriptions of the subspecies *semifasciata*. Dr. J. S. Nelson of the University of Alberta verified the author's identification of the specimen.

The presence of *Percina caprodes semifasciata* in Cold Lake, Alberta, represents a modest extension of its known range and is the first record of this species in Alberta. Collecting during the summer of 1971 also yielded new locality records for the cyprinid fishes *Chrosomus neogaeus* (Cope), the finescale dace, and *Semotilus margarita* (Cope), the pearl dace; their occurrence in Cold Lake represents considerable extensions of their known distributions within Alberta. Cold Lake contains the largest known number (22) of native fish species in Alberta, the Alberta portion of Lake Athabasca having the previous record of 21 known species (Paetz and Nelson. 1970. The fishes of Alberta. Queen's Printer, Edmonton). These new records are probably the result of more intensive collecting and critical examination of collections, but it is possible that they may be the result of the expansion of the ranges of these fishes.

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Winter Hunting of Snowy Owls in Farmland

Snowy Owls (*Nyctea scandiaca*) are fairly common winter residents about Edmonton, Alberta, from October or November until late March. When, in late January 1973, I saw one perched on a haystack a few miles south of the city, instead of merely looking at it through binoculars, I decided to watch it from the car for as long as might be required to see it in pursuit of prey. I was lucky on this occasion for it left its perch only 10 minutes later. After a low-level flight its aerial manoeuvering with lowered feet almost touching the snow, followed by perching on the snow-covered ground where it peered about, showed that it had sighted but failed to grasp its objective, presumably a small rodent. The interesting point was that the owl had spotted something not, as I expected, close to its perch, but about 150 yards away across a secondary road.

As this distance was obviously beyond the human range of perception for an object as small as a mouse, I decided to make further observations in the same area and continued these from January 21st until March 24th at various times of the day between 10:00 a.m. and 7:20 p.m. On the assumption that an owl seen repeatedly over most of this period on a few perches in the same area was the same bird, four females or immature males were observed for a total of 11 hours and 28 minutes, and one adult male for 40 minutes.

The perches used by these owls were haystacks about 15 feet high on 13 occasions; roadside power poles about 20 feet high on six; trees on three; and a fence post on only one occasion. Only in three instances did any of these Snowy Owls watch for prey from the snow-covered ground and in two of these, this stance was assumed after an unsuccessful attack flight from an elevated perch. Hence in flat country, as in the area in question, hunting from the ground is probably rare. When using haystacks, the owls would perch on the highest point on stacks which had more or less conical tops, but in the case of

flat-topped ones, would perch at the top of one of the nearly vertical sides rather than on the middle of the top.

With the exception of one owl which for a few minutes seemed to be sunbathing with loosened wings on the snow, the birds never just sat looking into the distance, but peered in one direction for a few (up to about 10) seconds, then rotated the head about 20° to peer in another direction, etc. Thus, although the head-turning was not necessarily in the same direction in successive movements the bird would in about a minute have looked all around itself. Shifting the whole body, as opposed to turning the head, was only rarely used as an alternate way of looking elsewhere. The owls would sometimes scan the scene in this way without even moving to another perch, for up to an hour, by which time my patience was exhausted. However, the average period that elapsed between the start of observations of a particular owl and its take-off in a hunting flight was only 22 minutes.

Owls perched on roadside power poles took no obvious notice of cars passing below but they would flush if a car stopped nearer than 40 yards. Owls on the ground would flush when cars passed within 30 yards, showing a greater flight distance than when they had been on an elevated perch. Take-offs followed by attack flights were in some cases made without any noticeable preliminary. In some cases the birds might gaze rather longer than usual in the direction of the subsequent flight. In other instances the owl would become more erect, raise its head, move the closed wings, defecate, and then take off in low-level flight. One, after raising its head, bobbed it up and down a few times while peering steadily ahead, then made movements suggesting defecation, and finally took wing.

Four out of the 12 attack flights observed were certainly successful, the mouse or vole caught by the owl being seen in its beak through 10-power binoculars. Another four attacks were probably successful as suggested by movements of the owl's head down to the feet when the bird landed on the ground near the point where it had swooped low over the snow with lowered feet, or after its return to a perch. The remaining four hunting flights were clearly unsuccessful. Attack flights, successful or not, were made to points 30 to 175 yards from the perch, the average distance of 12 flights being 98 yards. The longest observed flight of 175 yards happened to be made parallel to a road and could therefore be measured on the odometer of the car.

At such distances location of the prey must be visual since hearing ability is not superhuman even in owls (Pumphrey, R. J. Hearing and balance. *In* New Dictionary of Birds. A. L. Thomson. (Editor). London and New York). Dependence on vision was also suggested by the head movements which preceded some attack flights, and by the observation that owls scanning their surroundings from the ground directed their gaze slightly upwards compared to the horizontal gaze they used from elevated perches. Sighting small prey at up to 175 yards indicates an acuity of vision exceeding that of man for I found that I was unable to make out a stuffed red-backed vole pinned on a piece of cardboard set vertically on the ground when it was more than 107 yards away. This indicates that Snowy Owls have a visual acuity about twice that of man. This finding is quite compatible with the assessment, based on certain ocular measurements of the same author (Pumphrey, R. J. 1961. *In* Biology and comparative physiology of birds. Volume II. A. J. Marshall (Editor). Academic Press, New York and London. p. 57.) that the optical acuity of the larger birds may exceed that of man by a factor of two or three, but certainly not much more.

Mr. D. Dekker told me of his observation of an adult male Snowy Owl made during the late afternoon of December 5th, 1971, in the same area in which I watched in 1973. This bird did not become obviously active until dusk when it flew to the top of a power pole from which it made four sorties in quick succession, of which two were successful. Its last strike was made about 100 yards from its perch in an area of shallow snow riddled with runways in which the observer saw two voles scurrying for cover as he approached. This suggested to us that the rodents involved might emerge on top of the snow more frequently towards dusk and so elicit more frequent attacks by the owls. However, my 1973 observations did not bear this out. Owls that were watched on three different days as the afternoon light became weaker and merged into dusk, made fewer attack flights per unit time than during full daylight.

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First Records of Nesting by Marsh Hawks on Vancouver Island

As there are no published records of nesting by Marsh Hawks (*Circus cyaneus*) on Vancouver Island, Dr. W. Earl Godfrey has suggested that I record the following.

The observations that follow were made between 1969 and 1972 near Middle Quinsam Lake, approximately 12 miles west of Campbell River. This area is part of the east coast plain of Vancouver Island and is in early stages of forest regeneration after wildfires and logging operations. Ponds, bogs, and meadows are common, many the result of beaver dams.

David H. Mossop provided data for 1969 and David J. Low for 1972. The assistance of Dr. J. F. Bendell, Dr. C. J. Guiguet, Mr. F. L. Beebe, and Mr. R. W. Campbell is also gratefully acknowledged.

For several years prior to 1969 Marsh Hawks were occasionally observed along the north side of Middle Quinsam Lake on an area used to study Blue Grouse (*Dendragapus obscurus*). In 1969 a pair were seen regularly near an old beaver dam and in summer two newly-fledged youngsters appeared but no effort was made to locate the nest. When adults showed again in 1970, however, they were kept under close scrutiny. On May 6 their nest with four eggs was located by Mossop in the old beaver dam. The dam is approximately 300 feet wide and twice as long. It is entirely filled with sediments and supports a dense growth of sweet gale (*Myrica gale*) and sedges. The nest of sticks and other dead vegetation was among the sweet gale near the center of the dam.

The nest contained six eggs on May 10, 13, and 30 with the female incubating in each case. On the next visit, June 11, I found six chicks, cloaked in pale yellow down, which I estimated to be 3–5 days old. Thus, the incubation period was approximately 30–32 days and in agreement with that given by Godfrey (1966. The birds of Canada, National Museum of Canada Bulletin 203) and also by L. Brown and D. Amadon (Eagles, Hawks, and Falcons of the World. 1968. McGraw-Hill Book Co., N.Y. pp. 391–394). Six chicks still survived June 25 although three were much smaller than the others. At this time the smallest was still largely cloaked in down with primaries just out of pulp, while the largest had many juvenal feathers and half-grown primaries. On one occasion the male was seen passing prey, a bird, to the female who descended with it to the nest. Birds probably formed most of the diet, as voles and other small diurnal mammals are scarce in the area. The nest was not visited again but three of the chicks had vanished before July 16 when the remaining chicks were first observed flying. Death probably came during a cold wet period between July 9 and 12 when temperatures dipped to 35 and 36 degrees.

In 1971 a pair returned to the same site but never nested. The spring was unusually wet and cold, with the result that the 1970 nest was partially flooded. By mid-June the pair had abandoned the area entirely and as far as is known did not nest elsewhere. In 1972 weather conditions were only slightly better but the Marsh Hawks managed to fledge two chicks. They had nested in meadows around another beaver dam a half mile from the earlier site.

While this note was being prepared another unpublished record of Marsh Hawk nesting on Vancouver Island was brought to my attention. Mr. R. Wayne Campbell of the British Columbia Provincial Museum informed me that he had found a nest on June 9, 1967, among willows in a slough near Comox. He flushed the female off four small down-covered chicks, but the fate of this nest is unknown. No other incidents of nesting are known to staff of the Museum.

Marsh Hawks are normally associated with marshes, fields, and prairies. Their presence near Middle Quinsam Lake is, therefore, temporary, for in another 10 years a closed forest of conifers will dominate. It is probable that there has always been a small but shifting population on Vancouver Island as different areas opened because of wildfire and, in recent times, man's activities. Sight records along the eastern side of the island and southern tip are not uncommon, particularly in early spring and in autumn.

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Sight Record of Sage Thrasher near Cache Creek, British Columbia

On 23 April 1973 my wife and I observed a Sage Thrasher (*Oreoscoptes montanus*) cross the Trans-Canada Highway about 25 miles east of Cache Creek, British Columbia. Identification was based on the general mimid body shape and behavior of flicking the tail on landing, dark grayish-brown color with heavy streaks and underparts except under the tail, shorter tail and bill in relation to body size than in the Brown Thrasher (*Toxostoma rufum*), corners of white in the tail less extensive than the white borders of the Mockingbird (*Mimus polyglottos*) tail, and general Catbird size. These features separated it from the three other mimids known to occur in British Columbia: the Mockingbird, Brown Thrasher, and Catbird, all familiar to the writer. The straight bill also differentiated it from other potential stragglers.

The only other mimid likely to occur in the area is the Catbird (Godfrey 1966, p. 293; Edwards and Ritcey 1967). The Mockingbird has been noted at Wells Gray Provincial Park (Stirling 1960; Edwards and Ritcey 1967), but most British Columbia records are for the Pacific Coast (Stirling 1960; Campbell and Anderson 1968; several others). There appear to be only two British Columbia records of the Brown Thrasher (Cannings 1972; Campbell *in preparation* [Brown Thrasher on the coast of British Columbia]).

The Sage Thrasher, discovered in Canada by C. de B. Green in the Osoyoos area of British Columbia (Brooks 1909), is known to breed regularly at Osoyoos, White Lake, and the Similkameen Valley in south-central British Columbia (Munro and Cowan 1947; Godfrey 1966, p. 294), and in one area of Saskatchewan (Godfrey 1966, p. 294). It has also been recorded at Okanagan Landing in the same valley system (Brooks 1925); this is presumably the basis for its status as "casual in the Dry Forest Biotic Area" (Munro and Cowan 1947). The only record published for British Columbia away from the Okanagan and Similkameen Valleys is of one bird seen by Richardson (1971) on 8 May 1969 at Grant Bay on the northwest coast of Vancouver Island. Even in those parts of the province in which it is regular, it is fairly uncommon (R. W. Campbell, personal communication).

I should like to thank R. Wayne Campbell and W. Earl Godfrey for their comments on the manuscript.

Literature Cited

Brooks, A. 1909. Some notes on the birds of Okanagan, British Columbia. Auk 26: 60–63.

Brooks, A. 1925. Three noteworthy records for British Columbia. Condor 27: 211–212.

Campbell, R. W. and **W. J. Anderson.** 1968. Mockingbird at Vancouver, B.C. Canadian Field-Naturalist 82: 227.

Cannings, S. R. 1972. Brown Thrasher in British Columbia. Canadian Field-Naturalist 86: 295.

Edwards, R. Y. and **R. W. Ritcey.** 1967. The birds of Wells Gray Park, British Columbia. Parks Branch, Department of Recreation and Conservation, Victoria, British Columbia. 37 pp.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin Number 203, Biological Series No. 73. Ottawa. 428 pp.

Munro, J. A. and **I. McT. Cowan.** 1947. A review of the bird fauna of British Columbia. British Columbia Provincial Museum Special Publication Number 2. 285 pp.

Richardson, F. 1971. Birds of Grant Bay and Browning Inlet, northwest Vancouver Island, British Columbia; a year's phenology. Murrelet 52: 29–40.

Stirling, D. 1960. Two records of the Mockingbird in British Columbia. Canadian Field-Naturalist 74: 176.

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Lark Sparrow on Vancouver Island

On February 7, 1973, a Lark Sparrow (*Chondestes grammacus*) was spotted on a lawn at 3900 Hobbs Street, Saanich (Greater Victoria) on southern Vancouver Island by Mr. and Mrs. J. E. V. Goodwill. The bird was observed with 7 × 50 binoculars at a distance of 35 feet for about one minute under ideal lighting conditions. On-the-spot field notes were made, a copy of which has since been received by the British Columbia Provincial Museum. Two days later, pres-

umably the same bird was seen at the feeding station of Miss Betty Lothian, 2515 Arbutus Road, which is less than one-quarter of a mile from the original sighting. Nearly two months lapsed before the bird was observed again. On March 31, 1973, the Lark Sparrow showed up at the author's feeding station at 2511 Kilgary Place, which is in the immediate vicinity of the other sightings. Ten 35-mm color slides were taken to document the sighting, all of which have since been added to the Photoduplicate File of British Columbia Vertebrate Records (Catalogue Number PDF 280) which is now housed in the British Columbia Provincial Museum in Victoria (see Campbell and Stirling 1971). For comparative reasons, several slides were obtained to show the Lark Sparrow at the feeding station with House Finches and Fox Sparrows. The following day, April 1, the sparrow was seen by E. C. Campbell, K. Kennedy, and the writer and then daily by my wife until April 6 at the same location.

It is likely the bird was a yearling in its first winter plumage. The colors, especially in the markings on the head, were generally rather dull and the markings on the outer tail feathers were buffy white, rather than a solid white, which is characteristic of adults in winter plumage (Bent et al. 1968). Both age classes show the dark brown central chest spot at this time of year.

The Lark Sparrow was seen again on May 13 by my wife and me in our backyard. During its absence since early April the bird had acquired full nuptial plumage. Colors on the head especially, were noticeably more intense. The auricular patch and crown were chestnut, the malar streak and superciliary line appeared black, with the interspaces on the head snow-white. The bird has not been reported since.

In British Columbia the Lark Sparrow is a fairly common summer visitant to the south-central interior of the province (Munro and Cowan 1947). The only coastal records are from Chilliwack, about 60 miles east of Vancouver. A specimen was taken there on May 21, 1889, while another bird was seen in the spring of 1896 and a breeding pair was seen there in 1899 (Brooks 1917). The Saanich record represents the first occurrence of the Lark Sparrow on Vancouver Island and the only coastal record for British Columbia since the turn of the century.

Literature Cited

Bent, A. C. and **Collaborators.** 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. Part II. United States National Museum Bulletin 237: 886–899.

Brooks, A. 1917. Birds of Chilliwack District, B. C. Auk 34(1): 45.

Campbell, R. W. and **D. Stirling.** 1971. A photoduplicate file for British Columbia vertebrate records. Syesis 4: 217–222.

Munro, J. A. and **I. McT. Cowan.** 1947. A review of the bird fauna of British Columbia. British Columbia Provincial Museum Special Publication Number 2.

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News and Comment

Recent Changes in Bird Names

The American Ornithologists' Union's Committee on Classification and Nomenclature has published (1973. The Auk 90(2): 411–419) a substantial supplement to its Check-list of North American Birds (1957. 5th ed.). The changes thus made in ornithological nomenclature are fairly numerous, and some of the common North American bird species are importantly affected. The changes are intended to conform to the treatment currently believed to be correct by the majority of active authorities on avian systematics. They fall into two main groups: changes for purely nomenclatural reasons, many of them required by the International Code of Zoological Nomenclature (1961), and changes involving taxonomic decisions. There are some particularly welcome improvements in vernacular names. For example, Sparrow Hawk becomes American Kestrel; Pigeon Hawk is now Merlin; Wood Ibis is changed to Wood Stork; and Upland Plover is now called Upland Sandpiper.

As it is a policy of *The Canadian Field-Naturalist* to follow the American Ornithologists' Union in ornithological nomenclature, contributors of manuscripts dealing with birds are requested to familiarize themselves with this latest supplement to the AOU Check-list of North American Birds.

W. Earl Godfrey
Associate Editor (Ornithology)

The World's Largest National Park

According to the 1973 UN List of National Parks and Equivalent Reserves, the largest National Park in the world is Wood Buffalo. Although this park, with 44,807 sq km, is in Canada, 12 of the 17 parks with areas of 10,000 sq km or greater are in Africa. The only other Canadian National Park in this category is Jasper with 10,870 sq km.

IUCN Venture

We applaud the International Union for Conservation of Nature and Natural Resources for its current project. Through its Commission on Education it is trying to foster programs to teach conservation education in three countries.

In Kenya once fertile land lies barren, wildlife species are disappearing, and man and machinery are laying waste the country. In Venezuela, the pressure of a growing population aggravates environmental problems such as water pollution, exploitation of renewable resources, and disappearance of wildlife species. And in India, gravely reduced forest areas, dry and eroded lands, polluted air and water, worn-out soils, and endangered species of plants and animals are some of the problems that need attention.

These environmental conditions are all caused by people and their habitual misuse of the world's resources. The people must be taught to change their attitude toward their environment. Current programs of conservation education need teaching materials, especially books, for youth, the leaders of the future, so that they can understand the need to help end, or at least lessen, the destruction of nature.

To this end, a team of local educators and conservationists in each of the three countries, aided by IUCN and UNESCO, is in the process of preparing, publishing, and distributing popular booklets with local examples and problems to illustrate their message. It is hoped that the booklets will create awareness, concern, and a sense of responsibility for nature and its use in the young people of the countries.

Initially, 30,000 booklets, at a cost of $3,000 (US), will be needed, and UNESCO asks for financial assistance to carry out this project. If you wish to help, you may buy UNESCO Gift Coupons from any UNESCO office.

Please send your Gift Coupons to:

GCP - 528 - Youth Action for Conservation of Nature
c/o Education Executive Office
International Union for Conservation of Nature and Natural Resources
1110 Norges, Switzerland

Abstracted by
Marilyn D. Dadswell

Book Reviews

BOTANY

Flora of the Pacific Northwest — An Illustrated Manual

By C. Leo Hitchcock and Arthur Cronquist. University of Washington Press, Seattle. 1973. xix + 730 pp. illus. $25.00 (U.S.).

In 1969, Hitchcock, Cronquist, and Ownbey published the first, but actually the last, part of the five-volume work, *Vascular Plants of the Pacific Northwest*, which was begun with volume 5 in 1955. This work is an essential tool for all serious students of the flora of the northwestern United States and adjacent territories. Parts 5 to 2 were reviewed in this Journal by J. A. Calder and Part 1 by W. J. Cody.

The present volume consists of a short introduction, a list of abbreviations and signs used, a glossary, and the flora proper. The flora is an abbreviation of the *Vascular Plants*. It has both a synoptical and artificial key to families, and then the family and generic description and the keys. These are essentially the same as in the *Vascular Plants* but are compressed through the use of numerous abbreviations and signs. Information as to abundance, range, and some synonomy is also provided in abbreviated form. Species are described individually only when there is but one species in a genus.

Many of the excellent line drawings which were used to illustrate the *Vascular Plants* have been used to illustrate the key. These have been supplemented by some new drawings by Mrs. Jeanne R. Janish. These drawings are approximately half the size as when used in the *Vascular Plants* but little clarity is lost in this reduction. They are located along the left-hand margin of the pages and are adjacent to the respective parts of the keys to which they pertain. This is a feature which sets this flora above its predecessor.

Users of this book will find that the abbreviations will at first make consultation of the text somewhat more difficult. The publisher has obviously realized this fact because he has provided pages ix and x as a separate which may be kept readily at hand rather than having to consult those pages listing the abbreviations at the beginning of the book.

The publication of this book will now mean that an up-to-date flora treating the plants of Washington, northern Oregon and Idaho, western Montana and southern British Columbia is available at a relatively small cost. The *Vascular Flora* costs about four times as much and thus is beyond the reach of many students.

It is inevitable that in a book of this size a few errors will creep in. The authors have already found a few and have provided a separate sheet listing these errata. These however do not detract from the value of the book.

The authors have had a history of producing fine botanical works. They are to be congratulated once again.

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ZOOLOGY

Guide sonore des oiseaux du Québec (Volume 1)

Par Jean Bédard. La Société zoologique de Québec, Inc. Collection Chouette, distribuée par London Records of Canada Ltd. Disque long-jeu, 33 rpm (aussi disponible sous forme de musicassette et de cartouche-8-pistes). 1972. $3.98.

Ce guide, le premier du genre produit au Québec, est destiné à accompagner *Les Oiseaux du Québec* de R. Cayouette et J.-L. Grondin (1972, La Société zoologique de Québec).

On y retrouve les chants de 82 espèces d'oiseaux, qui ont été groupées par habitats. Ces groupements sont dans l'ensemble assez judicieux, mais parfois incorrects. Ainsi, le Pinson de Lincoln n'est pas un oiseau «des champs abandonnés envahis par les arbustes et en bordure des forêts,» mais bien une des espèces les plus typiques des tourbières, un habitat remarquable du Québec méridional.

Les enregistrements sont en général d'excellente qualité, bien que j'aie quelquefois noté une faible distortion dans les fréquences les plus élevées. On

aurait dû, dans certains cas, offrir une plus grande variété dans le répertoire de chaque espèce, pour ainsi présenter à la fois des chants typiques de même que des chants moins courants. On aurait pu ainsi réduire le nombre des espèces et présenter une plus grande variation sur le plan individuel. Ainsi, on aurait eu avantage à placer un enregistrement du chant le plus courant de la Fauvette à gorge orangée en plus du chant moins bien connu qu'on peut entendre sur le disque.

Malgré ces quelques faiblesses, j'ai été impressionné par la qualité uniforme des enregistrements et c'est avec impatience que j'attends les volumes suivants.

La narration, exclusivement en français, est brève, ne comportant que le nom de l'espèce à être entendue, ainsi que quelques mots concernant les groupements écologiques utilisés; la narratrice a une voix agréable et présente chaque espèce d'une façon impeccable, quoique j'aie été un peu dérouté par la prononciation du mot «junco».

C'est avec enthousiasme que j'offre mes félicitations à la Société zoologique de Québec, à l'auteur, ainsi qu'à tous ceux qui ont contribué à la réalisation de ce disque qui ne saurait manquer d'avoir un grand succès.

Le présent album constitue un achat remarquable à un prix aussi bas.

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An Index to the Described Life Histories, Early Stages and Hosts of the Macrolepidoptera of the Continental United States and Canada

By Harrison Morton Tietz. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007. 1972. (Originally published by A. C. Allyn for the Allyn Museum of Entomology). 2 vls., iv + 1042 pp. $25.00 set. With introduction by W. D. Field and J. F. G. Clarke.

These two volumes doubtless represent one of the most valuable and important works of recent origin in American lepidopterology. The publishers are to be congratulated on undertaking a work of such major proportions. Anyone working with immature stages of North American Lepidoptera, including the present reviewer, will appreciate this guide to antecedent publications as an aid to efficiency. Only after searching the literature for hours, often not knowing if the crucial reference has still been missed, can one fully acknowledge the value of Tietz's work. To give an example taken from my own practice: checking the genus *Orgyia* which I am now revising, I was delighted to find four pages of references for *O. leucostigma*, including one by Dyar (1891) on egg-mass structures of the North American species, that I had not found before.

The method of arranging references adds to the usefulness of the index. The first list is of the periodical literature for a given species in alphabetical order according to the name of the journal containing the reference. Then follows the list of separate works, alphabetically by author. The life history stages described in the quoted papers are, of course, noted, as are illustrations where available. Recorded food plants complete the treatment of each species. All species, subspecies, and names of lower taxa, including synonyms, are listed alphabetically and cross-referenced. A list of common names may be found in part I, section B.

Part II gives zoological hosts in section A, plants in section B with their common and Latin names; in section C plants of indefinite designation plus Lepidoptera "enemies" among them are listed; in section D scientific names of the plants, including Lepidoptera "enemies", with the Lepidoptera living on them, are given. Finally, section E notes some changes in plant nomenclature.

The bibliography ends at about 1950, and it is only to be hoped that someone will continue Tietz's work up to date. This would be another valuable accomplishment and a well-deserved posthumous acknowledgment of Harrison Morton Tietz (1895–1963) and his unique work in American lepidopterology.

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Systematics and Biology of the Woodland Jumping Mouse, *Napaeozapus insignis*

By Robert E. Wrigley. Illinois Biological Monographs 47. University of Illinois Press, Urbana, Chicago, and London. 1972. 118 pp., 22 figures. $7.95 paper.

Woodland jumping mice are mainly nocturnal, hibernating, brightly-colored rodents inhabiting the spruce-fir and hardwood-hemlock forests of eastern Canada and the northeastern U.S.A. As they tend to be highly localized in cool, damp habitats with much vegetative, log, or rock cover, they are sufficiently rare to evoke a thrill in the mammalogist finding one of these bautiful creatures in a trap, handling it, and watching it bound away after release. On the other hand, they are occasionally sufficiently common locally that the thrills of capturing them are frequent. Although some information on this species has been collected by a multitude of workers, it has been scattered through the literature or was unpublished, and many aspects of the biology of woodland jumping mice were unknown. The former situation obtains no longer, for Wrigley has done a great service for mammalogists by compiling much of the existing information on *Napaeozapus* from the literature, museum labels and data files, and from the notebooks of other workers through correspondence. These sources have been supplemented by his own observations from five years of field work, considerable laboratory investigation, and his analyses and interpretation, so as to elucidate some of the mysteries about this species. In so doing he has produced a monograph that sets a high standard for future students to emulate.

The first half of the book deals with phylogeny; morphology including karyology; variation — age, individual, secondary sexual, and geographic; distribution; and subspeciation. He used modern analytic techniques on morphological data from 2529 museum specimens to produce the first systematic revision of the genus, which has only the one Recent species, since 1899. He concluded that the seven races described should be reduced to five, four of which occur in Canada, and all are treated in detailed accounts.

The second half deals with other aspects of the biology of *Napaeozapus*: habitats (his discussion is based on detailed regional data in an appendix); food habits; interspecific relations; physiology, especially thermoregulation and hibernation; survival; reproduction; molt; population ecology — age structure, sex ratios, population density, and home range; predators; parasites; activity and behavior — burrows, locomotion, activity periods, and sociability. He cites 132 references.

Although Wrigley's monograph is valuable because it has brought together what is known about *Napaeozapus*, it is perhaps equally valuable in pointing out either directly or by omission what remains to be discovered. Some of the more tantalizing topics in need of investigation are the so-called colonialism; complementary patterns of distribution of *N. insignis* and *Clethrionomys gapperi*, the boreal red-backed vole, perhaps because of aggression by the latter towards the former; many aspects of reproduction, including the gestation period; the validity of the poorly known subspecies *N. i. saguenayensis*; longevity; most aspects of population dynamics; and the absence of abnormally-colored specimens. Wrigley thus provides us with numerous problems on which to focus future studies.

The format of the book is conventional, the type readable, the figures clear, the organization good, the material well-documented and interesting, the style concise and straightforward, but the price is unfortunately rather high, following the modern trend for scholarly works even in paperback. I noted only two typographic errors ("quadrats" and "*Ctenophthalmus*" are misspelled on pages 93 and 94, respectively), a few unclear or awkward sentences, and such infelicities as the repeated misuse of "comprise" and "which." The only factual inconsistency I spotted (on page 73) probably stems from a museum– and field-man's unfamiliarity with the jargon of physiologists: an upper critical temperature of 37°C is inconsistent with a thermoneutral zone from 31° to 33.5°C! The two-page index is incomplete (try looking up as I did the main accounts of any of the five valid races of *N. insignis*), but when used in conjunction with the list of Contents is adequate. The sparse list of parasites of *Napaeozapus* might have been amplified by delving into the "parasite literature" rather then just the mammalogical. For instance, Holland's (1949. The Siphonaptera of Canada. Department of Agriculture Technical Bulletin 70) Ontario records of *Megabothris quirini* and *Peromyscopsylla catatina* have been omitted, as were the record of *Ctenophthalmus pseudagyrtes* from Pennsylvania by Holland and Benton (1968. American Midland Naturalist 80: 252–261), and the older records of *C. pseudagyrtes* and *Trichopsylla* (= *Megabothris*) *quirini* by Costa Lima and Hathaway (1946. Pulgas: bibliografia, catálogo

e hospedadores. Monografias do Instituto Oswaldo Cruz 4: 1–522).

The above minor complaints to the contrary, this welcome and excellent species monograph belongs in the working library of all of us mouse-trappers active in the range of these intriguing mammals, and it should have a great influence on our future scientific endeavors in clearing some of the current clouds of mystery surrounding them.

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The Visible Migration of Birds at Ottenby, Sweden

By Carl Edelstam, Editor. Var Fagelvärld Supplement 7. 360 pp. Sveriges Ornitologiska Forening, Runebergsgaten 8, S-114 29 Stockholm. 95 Swedish cr.

"This book is a result of the counts of migrating birds made at the southern point of the island of Öland during the summers and autumns 1947–1956 by a group of enthusiastic and determined ornithologists associated with the Ottenby Bird Station. The purpose of their effort was to construct as detailed a picture as possible of the south-bound diurnal migration over one of northern Europe's major assembly points for migratory birds" (Editor's Preface). Öland lies in the Baltic Sea east of the Swedish mainland.

After a description of the organization of the program, the methods and the limitations of the observations, the book presents the data in tables and bar graphs. Short explanatory chapters review annual variations, seasonal rhythms, diurnal rhythms, and daily variations. There is a chapter on reverse migration and one on the influence of weather.

The project reported was one of several large cooperative studies of visible migration begun in Europe just before it became apparent that bird movements were displayed on a grand scale on radar screens. The use of radar has eclipsed the contribution of ground observers because on radar screens one can see what was unseeable. But radar is a very blunt instrument and restricts its user to simple and general (or typological) questions. For a complete picture of the means and mechanisms of migration, it is necessary to understand population aspects such as migration peaks of different geographic elements and the local weather conditions which influence air-borne migrants to alter their routes. It should be clear by now that radar studies are complementary to, but incomplete without, coordinated ground observations. Ground observations are inescapably labor-intensive and still largely the bailiwick of amateurs.

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Growth and Ecology of Fish Populations

By A. H. Weatherley. Academic Press, London and New York. 1972. 293 pp. $13.50.

The indeterminate pattern of fish growth has long been recognized as a challenging and sometimes vexing phenomenon that greatly complicates analysis of fish-production systems. Curiously, it is only in recent years that substantial progress has been made in unravelling fish-growth processes, progress that is in large part predicated on metabolic methods long since found useful in homotherms.

Weatherley has more or less succeeded in capturing the highlights of fish-growth research in one convenient volume, resulting in a book that, in his words, should "bring fish to the wider attention of ecologists and students of ecology . . . [and] . . . be useful to biologists specializing in fish ecology or fisheries research." It is by no means an indispensable work, but it nevertheless should be acquired by anyone with a serious interest in fish ecology.

The approach Weatherley has taken is somewhat exceptionable, in that he has produced something much more akin to a highly selective review of individual papers, rather than the orderly synthesis a prospective reader might expect from the title. It is true that mastery of a subject comes most rapidly from direct exposure to the litera-

ture, but newcomers to the field should be warned that much of the real work of synthesizing has been left for them to do. The literature selected for review provides an adequate sampling despite some notable exceptions (Baranov, Moiseev, Patten, Shaeffer, Silliman, etc.) that will be eventually picked up by anyone who works diligently through the bibliography. Unfortunately, although the nominal publication date is 1972, coverage of the recent literature is not effective beyond 1968 or 1969. A lot has happened since then, but these are now matters for the next edition.

Finally, and of lesser importance perhaps, the reader should not expect to obtain new ecological insights; the conceptual basis of the book is essentially that of Allee, with an added dash of the Watt/Van Dyne et al. school of "systems ecology," which results in an analytical point of view that is strongly reductionist and species-oriented. It remains for someone to integrate fish-growth and production processes with the extensive conceptual context provided by current ecological theory.

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ENVIRONMENT

Natural Resource Policy in Canada

By Thomas L. Burton. McClelland and Stewart Ltd., Toronto. 1972. 174 pp. Paperback only, $3.50.

The author stated that the purpose of this book is to provide a basic introduction to natural resource policy issues in Canada. This the author does very well, but he also goes much further and gives his personal views on how to resolve some of the problems regarding resources and resource usage.

The book is opened by a short preface and a long prologue, and these are followed by seven chapters entitled The Historical Perspective; Natural Resources and Economic Growth; Canadian Resources and International Relations; The Constitutional Setting; Party Political Themes; The Environmental Conscience; A Personal View. At the end of each chapter there is a "Notes and References" section, and following the final chapter there is a section entitled "Bibliography." However, some references in the "Bibliography" are not in the "Notes and References," and vice versa. The bibliography is not really a bibliography, but merely a list of additional, pertinent reading which could have been placed in parts at the end of each chapter.

In my opinion, the book is very well organized, clearly and forcefully written, and does not lose sight of the historical perspective. The history of Canadian natural resources policies started with the 1878 return of the Macdonald Government to office, and the development of the "doctrine of usefulness." The Government's single-minded objective was to forge from the several disparate regions of Canada a true Canadian nation, and the tools for achieving this were to be the railways and the abundant natural resources of the West and the near-North. From this start to the present, the major concern of economists, politicians, and planners alike has been to induce a continuous increase in the Gross National Product. Only recently have we come to question the wisdom of this philosophy.

The author stated, "We must instill in Canadians, of all ages, an understanding of the relationship between environmental quality and further economic growth . . . and a perception of the potential consequences of unrestricted population growth. Environmental studies must be . . . a major element of adult education and public relations programs." He stated also that we must have a major shift in societal ethics, and that we are faced with an environmental and resources crisis of major proportions. These statements are all too true!

The book is firmly bound with an attractive cover showing a mist-shrouded waterfall. The type is large and clear. I found only one typographical error or omission (p. 21, last line: the year (1970) is lacking).

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Philosophers of the Earth: Conversations with Ecologists

By Anne Chisholm. E. P. Dutton and Co., New York. 1972. 201 pp. $10.75. Available in Canada from Clarke, Irwin and Co., Toronto.

The title is apt. The "conversations" are more often quotations and the author unobtrusively adds biographical sketches. We are given photographs of 13 of the 20 or so people interviewed.

The author starts with the dictionary definition of ecology, casually admitting she first heard the word in 1969. She lets her subjects present their own ideas on ecology as "an abstract way of looking at things," "a specific branch of biology," "an instrument of social and economic change," and as "a science."

A couple of field trips are described. The detailed field work, the narrow, specific, painstaking and almost fanatical note-taking that was the early training of many of her subjects is presented as a prelude to the concepts of the "philosophers of the earth" as they mature and generalize.

The author does not follow any one leader. She "compares and contrasts" in the best academic tradition: Commoner and Erlich, American outspokenness and over-emphasis and British understatement; the practical approach to pollution in the capitalist economies of Europe and under Communism (Czechoslovakia).

If the book had any starting points they were Rachel Carson's *Silent Spring* of 1962, and William Vogt's *Road to Survival* of 1949. Darwin is, of course, in the background.

In no way is this a poor book. It is readable. It reflects the thinking and the work of many men and one or two women wandering in the wide, mistily defined meadows of ecology and environmentalism. Human ecology pervades the pages. It is a book about people, their interactions with other people, and their environments. It is a book for slow reading, a spur to thought, an aid to understanding, and a fine job of reporting.

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Alternatives to the Internal Combustion Engine: Impacts on Environmental Quality

By Robert V. Ayres and Richard P. McKenna. Published for Resources for the Future Inc. by John Hopkins University Press, Baltimore and London. 1972. 324 pp. 90 figures. $12.00.

The book was written as one of a series for Resources for the Future of Washington, D.C. to inform the public on matters of current concern.

In 1968 there were about 100,000,000 vehicles with Otto-Cycle internal combustion engines on the roads of the United States (about 465,000 diesels also). The automobile and related industries (highways, petroleum, etc.) in 1966 involved over 80,000 business establishments and nearly 15% of the gross national product. Consumer expenditures for automotive transportation (depreciation, maintenance, gasoline, oil, insurance) were $1,000 per household in 1965 or nearly 10% of all personal income.

The book does not attempt to deal with other types of transportation systems except to say that if automotive transportation were replaced by mass transportation, improved communications, etc., about 15% of the U.S. economy as it now exists would have to be replaced.

The book limits itself to alternative power sources for automotive vehicles. Those considered include external combustion engines (steam, Stirling Cycle) and electric power and hybrids between the two. Electric power using storage (batteries, etc.) or direct conversion (fuel cell) is considered with all its advantages and problems. There is some discussion of gas turbines and some other internal combustion engines (Wankel, etc.) as a comparison to typical Otto Cycle internal combustion piston engines. The external combustion and electric alternative power sources were real competitors of the internal combustion engine in the early 1900's. They lost out in the 1920's through public acceptance of the internal combustion engine. They may again return to popularity for environmental reasons (reduced pollution).

The book is a review of the state of the automotive art during the past 70 years. There are no easy answers to our present air pollution problems, either with modified internal combustion engines or substitutes for them.

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The Closing Circle

By Barry Commoner. Alfred A. Knopf, New York. 1971. 326 pp. $8.25. Available in Canada from Randon House of Canada Ltd., Toronto.

One edition of the book bears a note "the best book on ecology ever written." It is certainly the best book written for the general reader on the present position in technology, environmental management, and environmental problems. It discusses not only how we got here, but more important for the future, why we got here. It presents facts in a straightforward way and outlines the *real* alternatives for our future.

Commoner has really thought the whole thing through. He shows how all our complex history has put us where we are. His examples range widely from Los Angeles smog to Egyptian schistosomiasis by way of Lake Erie and nuclear power production. He stresses that rapid technological change has been more damaging than expanding populations. He asks each of us to think about and work toward a more just and less wasteful society here and throughout the world.

This is a mature look at all our past traditions and institutions, social, cultural, economic, and ecologic. If we use our common sense, we will change many of our goals for the future. We could improve many aspects of our life by living in harmony with the earth, its resources, and its peoples. If we don't soon change goals, the future may be short.

Commoner closes with the lines: "In our progress-minded society, anyone who presumes to explain a serious problem is expected to offer to solve it as well. But none of us—singly or sitting in committee—can possibly blueprint a specific "plan" for resolving the environmental crisis. To pretend otherwise is only to evade the real meaning of the environmental crisis: that the world is being carried to the brink of ecological disaster not by a singular fault, which some clever scheme can correct, but by the phalanx of powerful economic, political, and social forces that constitute the march of history. Anyone who proposes to cure the environmental crisis undertakes thereby to change the course of history.

But this is a competence reserved to history itself, for sweeping social change can be designed only in the workshop of rational, informed, collective social action. That we must act is now clear. The question which we face is how."

This is a must book for everyone on our small, finite planet.

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Energy: Crisis in Power

By John Holdren and Philip Herrera. A Sierra Club Battle Book, San Francisco and New York. 1971. 252 pp. $2.75. Available in Canada from Clarke Irwin Co., Toronto.

The Sierra Club, one of the oldest conservation agencies in North America, has produced a series of "battle" books dealing with subjects of concern to all persons concerned with North American landscape and resources. This is the fourth book of a series dealing with "forest utilization," "oil spills," "release of mercury." Each of those books is factual and each tries to explore all sides of the problem and to suggest solutions.

Energy provides a good review of trends in energy use, forecasts of future needs, and, if we do not change our ways, the kind of crisis we face. It reviews present use of fuels (fossil, hydroelectric, and nuclear). One chapter discusses future possibilities, including breeder reactors, fusion reactions, solar, geothermal, tidal and wind energy, energy from combustion of wastes and fuel cells. Another deals with the demand for power in relation to the actual need in the advanced countries and to the remainder of the world.

The author says "America's love affair with the automobile is the single greatest extravagance in the energy budget. Almost 16 percent of the energy consumed annually in the United States feeds the internal combustion engines of passenger cars, and another 2 percent is consumed manufacturing these vehicles. Yet the automobile is one of the least efficient forms of transportation, averaging only thirty-two passenger miles per gallon of fuel (pmg.) . . . Unfortunately, the mode of transportation whose use is increasing most rapidly with time—the aircraft—is even less efficient than the automobile. A Boeing 707 averages about 21 pmg."

"Shipment of freight is another mode of transportation in which considerable amounts of

energy are being squandered. A freight train gets from two to five times as many cargo ton-miles per gallon of fuel as does a truck, yet the percentage of intercity freight carried by trucks is increasing."

"As the need to reduce the environmental impact of energy use is taken seriously, energy prices will rise even faster and accelerate the demise of wasteful uses. Particularly in the raw materials industries, a rise in energy prices would have immediate substantial effects."

Half the book documents recent conflicts arising from attempts to meet future energy needs in ways which were thought acceptable in the past but are so no longer. There is a need to plan future power *production* and *use* in a way quite different from the history of the past.

Along with the comprehensive review of the present and proposed methods of power production, there is a good review of the safety features in present and proposed nuclear-fission power plants. A key concern of advocates of both nuclear power and conservationists is that there is only one way for radioactivity to dissipate from the waste products from a nuclear reactor, and that is slowly.

As the dangers and relative costs of attempts to meet future power needs become apparent to a larger segment of the population, more effort will be expended on the development of solar, geothermal, wind, and other environmentally-acceptable power sources and more rational use of energy. We can only hope that the authorities will begin to invest in those researches sums comparable to those already invested in the searches for nuclear and other less environmentally-attractive power sources in the past. The book should be read by all concerned members of the public. It is clearly written and well produced.

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James Bay: The Plot to Drown the North Woods

By Boyce Richardson. A Sierra Club Battlebook. Available in Canada from Clarke, Irwin and Co. Ltd., Toronto. 1972. 190 pp. $2.75.

The Destruction of Manitoba's Last Great River

By R. Newbury and G. Malaher. Special Publication Number 2, Canadian Nature Federation, Ottawa. 23 pp. $1.00.

Is northern development a goal in itself? Must we destroy our environment and the life styles of our native peoples in the name of progress, projected future requirements, and our energy-extravagant neighbours to the south? Both these publications try to answer these vital questions. They each oppose similar developmental projects involving the diversion and hydro damming of waters flowing into James Bay.

Richardson writes as an experienced, powerful, journalistic author. His book contains an abundance of scientific or newsworthy facts, but these are often overstated, presumably to make a popular impact, thereby convincing even the most unconcerned that the James Bay Project is a political fantasy that should be shelved, at least until proper environmental research has been done. Newbury and Malaher take a much more restrained and perhaps more scientific approach. They do not embellish the facts with obvious bias or rhetoric. They document their work well, merely presenting the evidence in such a clear, concise manner that the conclusion becomes obvious. They do not condemn all aspects of the Churchill River diversion, but instead prove that the power will not be needed prior to 1990 and emphasize that a great deal of study could take place in the interim, likely resulting in alternate, less environment-devastating sources of electricity.

Both publications take pot-shots at the politicians and the development corporations involved. Richardson's first chapter could be termed a political dissection. He censures the publicity stunts used to promote the project and proclaims that the whole James Bay Project is just Premier Bourassa's answer to adverse publicity over the FLQ crisis and a method of fulfilling election job promises. The project was apparently reported as unfeasible in two earlier reports. Although this may appear as a mud-slinging, unscientific method of criticism, it must be noted that this "antagonist" approach is very similar to those used by the politicians and developers who defend such projects. Newbury and Malaher complain about the

Manitoba N.D.P.'s mercurial policy of attacking the project when they were the opposition party, then going ahead with few if any changes when they were elected to power. These authors also note sarcastically: "To 'justify' the rapid expansion of power developments, Manitoba Hydro continues to light its offices in Winnipeg for 24 hours each day and has conducted an intense publicity campaign advocating that people use more electric power." This policy is illustrated by the inclusion of three Hydro ads in the paper's appendix.

Both publications give a comprehensive review of the history and environmental beauty of the areas to be destroyed by these projects. They also show clearly why the native peoples of each area oppose the respective projects. The destruction of natural resources caused by flooding and alterations to the local environment is discussed at length in each case. Richardson amplifies this section to the greatest degree, especially with regards to the Indians whom he pictures as traditionally suffering when the white-man makes decisions without any thought towards the rights of minority groups. This idea is pushed again and again, almost to the point of redundancy.

Both publications also emphasize the lack of research conducted in the affected areas, and the refusal to make public what little data are known. Although Richardson often complains that nothing is known of the possible environmental impacts, he does give an elaborate list of all of the possible adverse consequences of the project. Also, although he rightfully attacks the lack of impact research in the area and the official attitude that the project is inevitable, he spends as much time attacking the character of the impact report writers as he does the actual report. Perhaps this is unavoidable in an "adversary" approach.

Bearing in mind the aforementioned limitations, both these publications are highly recommended for anyone who is interested in Canada's future. The book by Richardson is especially important as it may have played a very significant role in challenging the right of government to decide arbitrarily the direction of northern development. The only way to influence politicians is by political means, i.e., by informing the people in a popular and highly emphatic manner. Richardson succeeds well. Perhaps these two publications and others to follow will spell the end of the seemingly traditional policy of developing *now* and worrying about the consequences *later*.

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NEW TITLES

Botany

Carr, D. J. (Ed.). 1972. **Plant Growth Substances 1970.** Springer-Verlag Inc., New York. 837 p. $19.10. Proceedings of the 7th International Conference on Plant Growth Substances held in Canberra, Australia, Dec. 7-11, 1970.

Correll, D. S., and H. B. Correll. 1972. **Aquatic and Wetland Plants of Southwestern U.S.** U.S. Environmental Protection Agency, Research and Monitoring Division. 1777 p. $7.75. For sale at U.S. Government Printing Office, Washington, D.C. 20402.

Dahl, Eilif, and H. Krog. 1973. **Macrolichens of Denmark, Finland, Norway and Sweden.** Scandinavian University Books, Oslo, Norway.

Gimingham, C. H. 1973. **Ecology of Heathlands.** Chapman and Hall, London, and Halsted (Wiley), N.Y. 226 p., illus and plates. $14.75.

†Kirk,, Ruth. 1973. **The Olymic Rain Forest.** University of Washington Press, Seattle. 86 p. $8.95 c'oth, $4.95 paper. Coloured and black and white photographs and text.

Knudsen, Jens W. 1973. **Collecting and Preserving Plants and Animals.** Harper and Row, New York, 320 p. $5.00 paper.

Liu, Tang-Shui. 1971. **A Monograph of the Genus *Abies*.** National Taiwan University, Department of Forestry. Taipei, Taiwan, China. 608 p. $25.00.

Lloyd, R. M., and R. S. Mitchell. 1973. **A Flora of the White Mountains, California and Nevada.** Univevrsity of California Press, Berkeley. 202 p. $8.00.

Rollins, R. C., and E. A. Shaw. 1973. **The Genus *Lesquerella* (Cruciferae) in North America.** Harvard University Press, Cambridge, Mass. 372 p. $9.95.

Skaptason, P. A. 1972. **Control of Aquatic Vegetation in Freshwater: A Bibliography.** U.S. Dept. Interior, Office of Library Services, Washington, D.C., 20240. 213 p. Bibliography Series No. 28. 851 citations from 1966 to 1971.

Standley, P. C., *et al.* 1973. **Flora of Guatemala.** Field Museum of Natural History, Chicago. $7.25. Fieldiana: Botany, Vol. 24, Pt. 9 (3 & 4).

Symonds, G. W. D. 1973. **The Tree Identification Book.** Morrow Pub. Co., New York. $6.95.

Symonds, G. W. D. 1973. **The Shrub Identification Book.** Morrow Pub. Co., New York. $6.95.

Voss, E. G. 1972. **Michigan Flora: A Guide to the Identification and Occurrence of the Native and Naturalized Seed-Plants of the State. Part 1: Gymnosperms and Monocots.** Cranbrook Inst. of Science, Bloomfield Hills, Mich. 488 p. $7.50.

Zoology

Ali, Salim, and S. D. Ripley. 1972. **Handbook of the Birds of India and Pakistan.** Together with those of Nepal, Sikkim, Bhutan and Ceylon. Vol. 7, Laughing Thrushes to the Mangrove Whistler. University Press, New York. 236 p. $17.50.

Angell, T. 1972. **Birds of Prey on the Pacific Northwest Slope.** Pacific Search, Seattle, Washington 98100. 33 p. $3.95.

Anon. 1972. **Population Ecology of Migratory Birds: A Symposium.** Bureau of Sport Fisheries and Wildlife, Wildlife Research Report 2. Washington, D.C. 20240. 278 p. For sale at U.S. Government Printing Office, Washington, D.C.

Anon. 1973. **Uptake of Toxic Water Pollutants (PCB) by Lake Trout.** Northern Michigan University, Department of Biology, Marquette, Mich. 19 p. $3.00. Obtain from National Technical Information Service, Springfield, Va., 22151. Document No. PB-214 768/4.

Barbour, R. W., C. T. Peterson, *et al.* 1973. **Kentucky Birds: A Finding Guide.** University Press of Kentucky, Lexington. 306 p. $9.75.

Bequaert, J. C., and Walter B. Miller. 1973. **The Mollusks of the Arid Southwest.** University of Arizona Press, Tucson, 271 p. $8.00.

Berger, Andrew J. 1973. **Hawaiian Birdlife.** University Press of Hawaii, Honolulu. 284 p. 59 color plates, photos, maps. $15.00. A sourcebook on the habits, biological relationships, and the place of birds in the ecosystem of the Hawaiian chain of islands, indigenous birds as well as migrants.

Blair, W. Frank (Ed.). 1972. **Evolution in the Genus *Bufo*.** University of Texas Press. 459 p. $17.50.

Burton, Robert. 1973. **The Life and Death of Whales.** Universe Books, New York. 160 p. $6.95.

*Cohen, D., A. W. Ebeling, T. Iwamoto, S. V. McDowell, N. B. Marshall, D. E. Rosen, P. Sonoda, W. H. Weed III, and L. P. Woods. 1973. **Fishes of the Western North Atlantic, No. 6.** Memoir Sears Foundation for Marine Research No. 1. New Haven, Conn. 698 p. $27.50.

Common, I. F. B., and D. F. Waterhouse. 1973. **Butterflies of Australia.** Waterhouse, Angus and Robertson Ltd., London. 498 p. $37.50 .

Eaton, R. L. (Ed.). 1973. **The World's Cats.** World Wildlife Safari, Winston, Ore. 350 p. Paper $10.00. Vol. 1, Ecology and Conservation proceedings of a symposium, Laguna Hills, California, March 1971.

Evans, John G. 1972. **Land Snails in Archaeology.** With special reference to the British Isles. Seminar Press, New York. 436 p. $22.50. Studies in Archaeological Science.

†Feduccia, Alan. 1973. **Evolutionary Trends in the Neotropical Ovenbirds and Woodhewers.** American Ornithologists Union Ornithological Monograph No. 13. 69 p. $2.00.

Gates, J. M. 1972. **Red-tailed Hawk Populations and Ecology in East-Central Wisconsin.** Wilson Ornithology Soc., Morgantown, W.Va., 26505. $10.00.

Halstead, B., and J. Middleton. 1973. **Bare Bones.** University of Toronto Press, Buffalo, New York. 120 p. $7.95. An exploration in art and science.

Hamerstrom, F. 1972. **Birds of Prey of Wisconsin.** Available from Wisconsin Department of Natural Resources, Box 450, Madison, Wisconsin 53701. 64 p. Descriptions of hawks, vultures, eagles and owls that migrate through Wisconsin or are residents, including a field key for identification.

Hassinger, J. D. 1973. **A Survey of the Mammals of Afghanistan.** Field Museum of Natural History, Chicago. 196 p. Illus. Fieldiana: Zoology, Vol. 60. Resulting from the 1965 Street expedition (excluding bats).

Harrison, R. J. (Ed.). 1972. **Functional Anatomy of Marine Mammals.** Vol. 1. Academic Press, New York. 452 p. $21.00.

Lucas, A. M., and P. R. Stettenheim. 1973. **Avian Anatomy.** Superintendent of Documents, Washington, D.C. Part 1, 340 p. Part 2, 341-750 p. $13.00. Agric. Handbook 362.

MacClintock, D. 1973. **A Natural History of Giraffes.** Scribner, New York. 134 p. $5.95. Pictures by Ugo Mochi.

McDonald, K. 1972. **Fish Watching and Photography.** John Murray Publication Ltd. London. 270 p.

Miller, Halsey W. 1973. **The Fossil Origins of Man.** Stipes, Champaign, Ill. (Ed.2). 188 p. Paper $6.90.

Morris, Percy A. 1973. **A Field Guide to Shells of the Atlantic and Gulf Coasts and the West Indies.** Houghton Mifflin, Boston. (Ed. 3). 330 p. Cloth $7.95, paper $4.95. Peterson Field Guide Series.

Perry, Richard. 1972. **At the Turn of the Tide: A Book of Wild Birds.** Taplinger, New York. 256 p. Illus. by Nancy Lou Gahan. $7.50. Foreword by Robert Arbib. Takes the reader among the water birds of the unspoiled wetlands of New England's eastern coast some 30 years ago.

Rothschild, B. J. **World Fisheries Policy:** Multidisciplinary Views. University of Washington Press. 272 p. $9.50.

Rue, L. L. III. 1973. **The World of the Ruffed Grouse.** J. B. Lippincott Co., Philadelphia. 160 p. $5.95.

Scott, P., and The Wildlife Trust. 1972. **The Swans.** Houghton-Mifflin, Boston, Mass. 242 p. $15.00.

Stonehouse, Bernard. 1971. **Animals of the Antarctic: The Ecology of the Far South.** Holt, Rinehart & Winston, New York. 171 p. 200 color photographs, maps. $10.95. Describes the southern polar continent, the islands and surrounding oceans, the true inhabitants of the region — its birds and mammals, and discusses man's threatening impact on this fauna.

Voous, K. H. (Ed.). 1972. **Proceedings of the XV International Ornithological Congress.** The Hague, 30 Aug.-5 Sept. 1970. E. J. Brill, Leiden. 745 p. price unknown.

Walkinshaw, L. H. 1972. **Cranes of the World.** Winchester Press, New York. 320 p. $25.00.

Wetmore, Alexander. 1972. **The Birds of the Republic of Panama.** Part 3. Passeriformes: Dendrocolaptidae (Woodcreepers) to Oxyruncidae (Sharpbills). Smithsonian Inst. Press, Washington, D.C. 632 p. $15.00. Smithsonian Misc. Collections. Vol. 150, Part 3.

Wingate, David B. 1973. **A Checklist and Guide to the Birds of Bermuda.** Native and visiting birds are listed, together with a detailed chart of seasonal distribution and abundance. Tips on how and where to watch birds in Bermuda are provided.

Environment

Anon. 1973. **Fresh Water Pollution.** MSS Information Corporation, New York. Vol. 2, Radioactive Pollutants. 228 p. $15.00.

Anon. 1973. **Exploring New Ethics for Survival.** Penguin, Baltimore. 274 p. Paper $1.45. Reprint of the 1972 edition. The voyage of the spaceship Beagle.

Anon. 1973. **Chemistry in the Envivronment.** Freeman, San Francisco. 362 p. Cloth $12.00. Paper $5.95. Readings from Scientific American.

Antoine, S., and A. Duret. 1972. **Protection et Amenagement des Espaces Verts.** La Documentation Française, Paris. 233 p. FF 25. Report of the "Comite Interministeriel Pour la Nature et L'environnement", 20 July, and Principal Rules. No. 11 in series "Environnement".

Antoine, S., and A. Duret. 1973. **Pour une Politique de Lutte Contre la Pollution des Mers.** La Documentation Française, Paris. 271 p. Illus., tables, maps and diagrams. FF 35. Report of the "Groupe interministeriel des Problemes de Pollution de la mer". No. 12 in the series "Environnement".

Cole, H. S. D., C. Freeman, M. Jahoda, and K. L. R. Pavitt (Eds.). 1973. **Models of Doom: A Critique of the Limits to Growth.** 244 p. Universe Books, New York. $8.00 cloth, $2.95 paper.

Coomber, N. H., and A. K. Biswas. 1973. **Evaluation of Environmental Intangibles.** Genera, Bronxville, New York (Ed. 2). 78 p. Paper $3.95.

Durrenberger, Robert W. 1973. **Dictionary of the Environmental Sciences.** National Press Books, Palo Alto, Calif. 282 p. Cloth $7.95, paper $4.95.

E.P.A. 1972. **A Catalog of Research in Aquatic Pest Control and Pesticide Residues in Aquatic Environments.** EPA Office of Water Programs, Rural Wastes Branch. 359 p. $2.75. Pesticide Study Series No. 1. U.S. Government Printing Office, Washington, D.C. 20402.

Frejka, T. 1973. **The Future of Population Growth: Alternative Paths to Equilibrium.** Wiley-Interscience, New York. 268 p. $9.95. A population council book.

Garvey, Gerald. 1972. **Energy, Ecology, Economy.** 1972. W. W. Norton Co., New York. 235 p. $8.95. Sets for the elements of a practical response, after developing a new framework for assessing the long-term environmental destruction caused during production, transportation and conversion of fuel needed to meet the heavy demands for energy.

Goldman, C. R., J. McEvoy, *et al.* 1973. **Environmental Quality and Water Development.** W. H. Freeman, San Francisco. 510 p. $17.50.

Grenon, Michel. 1973. **Ce Monde Affame d'Energie.** Robert Laffont, Paris. 313 p. Graphs, tables and diagrams. FF 26.

Heim, Roger. 1973. **L'angoisse de l'An 2000.** de la Fondation Singer-Polignac, Paris. 398 p. FF 28.

Miller, H. W., R. E. Yarbrough, *et al.* 1973. **The Earth and the Environment.** Stipes, Champaign, Ill. 264 p. $6.40.

Russell, Helen Ross. 1973. **Ten Minute Field Trips: Using the School Grounds for Environmental Studies.** A Teachers Guide. Ferguson (Doubleday) Chicago. 174 p. $6.95.

Scorer, R. S. 1973. **Pollution in the Air.** Problems, Policies and Priorities. Paul, Boston. 148 p. $8.50.

Viertel, Janet. 1973. **Blue Planet: The Ecology of the Oceans.** Grosset and Dunlap Inc.; George J. McLeod, Toronto. 128 p. $6.95. This book is aimed at the juvenile reader, and using the ocean as a stepping point, explains environmental problems and how to correct the ills.

Williamson, S. J. 1973. **Fundamentals of Air Pollution.** Addison-Wesley, Reading, Mass. 472 p. $14.95.

Canadian

Argus, George. 1973. **The Genus *Salix* in Alaska and the Yukon.** Publications in Botany No. 2, National Museum of Natural Sciences, Ottawa. price unknown.

†Bousefield, E. L. 1973. **Shallow-water Gammaridean**

Amphipoda of New England. Cornell University Press, Ithaca, N.Y. 312 p. $17.50.

Burnford, Sheila. 1973. **One Woman's Arctic.** McClelland and Stewart Ltd., Toronto. 222p. $6.95.

*Canadian Forestry Service. 1973. **Ecotour of the Trans-Canada Highway: Ottawa-North Bay.** Department of the Environment, Ottawa, K1A 0H3. An ecological and human-history-as-shaped-by-the-environment guide to a 250 mile section of Highway 17 in Ontario. This interesting map is available free from the Information Branch of the Canadian Forestry Service.

Clark, Arthur. 1973. **Freshwater Molluscs of the Interior Basin of Canada.** Malacologia, Vol. 13, No.'s 1 and 2.

*Dickson, Lovat. 1973. **Wilderness Man: The Strange Story of Grey Owl.** The Macmillan Co. of Canada Ltd. 281 p. $9.95.

†Doern, G. B. 1972. **Science and Politics in Canada.** McGill-Queen's University Press, Montreal. 238 p. $12.50.

Elliot, H. (Ed.). 1973. **Ecology Canada.** Earth City Foundation. Volume 1 No. 1 of a new ecologically oriented magazine. Subscription rate is $10.00 for 12 issues. 6902 Cote des Neiges, Montreal 249, P.Q. The issue includes an interview with Ken Dryden about his work with one of Ralph Nader's consumer protection teams, and an article on recycling household goods. The articles are informative and interesting, but subjects are not covered in great depth, nor is it clear at whom the magazine is aimed.

*Jackson, J. N. 1973. **The Canadian City: Space, Form, Quality.** McGraw-Hill Ryerson Ltd., Toronto. 237 p. $6.50.

Johnson, M. E. 1973. **Forest Products Pollution Control Annotated Bibliography.** Information Report VP-X-100 Supplement 1. Western Forest Products Laboratory, Canadian Forestry Service, Vancouver, B.C.

†Livingston, John A. 1973. **One Cosmic Instant: A Natural History of Human Arrogance.** McClelland and Stewart Ltd., Toronto. 243 p. $7.95.

†Peace-Athabasca Delta Project Group. 1973. **The Peace-Athabasca Delta: A Canadian Resource.** Inland Waters Directorate, Environment Canada, Ottawa. 144 p. $1.00. Available from Information Canada Bookstores; The Queen's Printer, Province of Alberta, Edmonton; The Queen's Printer, Province of Saskatchewan, Regina.

Potter, Alan B. 1973. **Pollution: A Study in Survival.** Palm Publishers Ltd., 1949 - 55th Ave., Dorval, P.Q. A book for students, with an accompanying teacher's manual at $4.40 and $2.00 respectively.

†Rowe, J. S. 1972. **Forest Regions of Canada.** Canadian Forestry Service Publication No. 1300. 172 p. $2.50. Available from Information Canada Bookstores, Cat. No. Fo47-1300.

†Salt, W. Ray. 1973. **Alberta Vireos and Wood Warblers.** Publication No. 3 of Provincial Museum and Archives of Alberta. Queen's Printer, Edmonton, Alta. 141 p. $4.50. Subtitled Families Vireonidae and Parulidae: Distribution and Breeding.

Miscellaneous

Angier, Bradford. 1963. **Wilderness Gear You Can Make Yourself.** Stackpole Books, Harrisburg, Pa. 115 p. $6.95. Available in Canada from George J. McLeod Ltd., Toronto.

Anon. 1971. **Nature Conservation in the Pacific.** Proceedings of a Symposium. Australian National University Press, Canberra. 338 p. $18.75.

Anon. 1973. **Nature's Teakettle. Geothermal Energy for the People.** HyDee Small, Geothermal Information Services, West Covina, California. 214 p.

Armstead, H. C. H. (Ed.). 1973. **Geothermal Energy: Review of Research and Development.** UNESCO, Paris or New York. 186 p. $14.00. Earth Sciences Paper No. 12.

Baetzner, W. H. 1973. **The Naturalists' Directory (International).** PCL Publications Inc., South Orange, N.J. Supplement to 41st edition. $2.00 if paid in advance.

Battaglia, B. (Ed.). 1970. **Fifth European Marine Biology Symposium, Venice.** Piccin, Padova, Italy. 348 p. L. 12,000.

Benthall, Jonathan (Ed.). 1973. **Ecology in Theory and Practice.** Viking Press. 367 p. $8.95. Theoretical part discusses biosphere without man, the impact of man on nature, the city and its environment, and the human skin as a model ecosystem. The practical part deals with contemporary issues, from sewage to social use and misuse of technology.

†Clark, Mary E. 1973. **Contemporary Biology: Concepts and Implications.** W. B. Saunders Co. Canada Ltd., Toronto, Philadelphia. 632 p. $11.85.

Collier, Boyd D., G. W. Cox *et al.* 1973. **Dynamic Ecology.** Prentice-Hall, Englewood Cliffs, N.J. 564 p. $11.95. Prentice-Hall, Biological Science Series.

Emlen, J. M. 1973. **Ecology: An Evolutionary Approach.** Addison-Wesley, Reading, Mass. 493 p. $14.95.

†Errington, Paul. 1973. **The Red Gods Call.** Iowa State University Press, Ames, Iowa. 171 p. $5.95.

Hadas, A., D. Swartzendruber, P. E. Rijtema, M. Fuchs, and B. Yaron. 1973. **Physical Aspects of Soil, Water, and Salts in Ecosystems.** Springer-Verlag Inc.,

New York. 430 p. $37.60. Vol. 4 in series Ecological Studies.

Klopfer, P. H. 1973. **Behavioral Aspects of Ecology.** 2nd edition. Prentice-Hall, Englewood Cliffs, N.J. 200 p. $7.95.

†Krutilla, J. V. (Ed.). 1973. **Natural Environments: Studies in Theoretical and Applied Analysis.** Johns Hopkins University Press, Baltimore and London. 352 p. $18.97. Available in Canada from Copp Clark Pub. Co., Toronto and Montreal.

May, R. R. 1973. **Stability and Complexity in Model Eco-systems.** Princeton University Press, Princeton, N.J. 236 p. Cloth $11.50, paper $4.95. Monographs in Population Biology 6.

Meggers, B. J., E. S. Ayensu, *et al.* 1973. **Tropical Forest Ecosystems in Africa and South America: A Comparative Review.** Smithsonian Inst. Press, Washington, D.C. 350 p. $15.00 cloth. $5.95 paper.

National Academy of Sciences. 1972. **Degradation of Synthetic Organic Molecules in the Biosphere: Natural Pesticidal and Various other Man-made Compounds.** Proc. of a Conf. San Francisco, June 1971. N.A.S. Washington, D.C. 350 p. $13.95.

Perry, Richard. 1973. **The Polar Worlds.** Taplinger, New York. 316 p. Maps. $7.95. Conservationist draws a parallel in this book between the physical environments of Arctic and Antarctic regions, delineating the links between them, the life histories and interrelationships of native species and their complex problems of adaptation.

Skinner, B. J., and K. K. Turekian, 1973. **Man and the Ocean.** Prentice-Hall, Englewood Cliffs, N.J. 150 p. Illus. Cloth $7.95. Paper $2.95. Foundations of Earth Science series.

U.S. Office of Water Resources Research. 1973. **Estuarine Pollution: A Bibliography.** Available from National Technical Information Services, Springfield, Va. 478 p. $3.00.

Yaron, B., E. Danfors, and Y. Vaadia. 1973. **Arid Zone Irrigation.** Springer-Verlag Inc., New York. 500 p. $37.60. Vol. 5 in series Ecological Studies.

Zeitzschel, Bernt. 1973. **The Biology of the Indian Ocean.** Springer-Verlag Inc., New York. Vol. 3 of series Ecological Studies. 549 p. $49.20.

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